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FLANGE AND PIPE THREAD STANDARDS

Dimensions and Precautions Necessary to Make a Proper Steam-Tight Joint

Since the advent of large units and high steam pressures, a good flanged joint which can easily be made tight, quickly removed and easily repaired has been found necessary. To answer all of these qualifications, it is necessary, among other things, that standards be adopted so that all flanges for a given diameter of pipe will fit each other when put together. Before the year 1894, there had long existed confusion regarding standards for pipes, fittings and valves. In that year, committees from the Master Steam and Hot Water Fitters' Association and American Institute of Mechanical Engineers met with the representatives of the leading valve and fitting manufacturers in the United States and established a standard for pipe flanges. This standard is given in the accompanying table and is generally adhered to.

Steam pressures varying from 100 to 250 pounds pressure entered into engineering practice about 1889 and as the use of these higher pressures became more general there came into existence so many different diameters, thicknesses, drilling circles and number of bolts for flanges that manufacturers could not keep stocks on hand and engineers were often greatly delayed in making repairs or extensions.

Since the need of a standard for extra heavy flanges was found to be as necessary as a standard for moderate pressures, a committee consisting of representatives of the largest valve and fitting manufacturers formulated the accompanying schedule, which was adopted by all the leading firms in this country and put into operation January 1, 1902. A comparison between a standard 10-inch flange and an extra heavy 10-inch flange is shown in Figs. 1 and 2. Fig. 1 represents a standard 10-inch flange, and Fig. 2 represents an extra-heavy 10-inch flange, according to the dimensions given in the tables.

The five principal things about a flange which should have standard dimensions are the flange diameter, bolt-circle diameter, number of bolts, size of bolts and thickness of flange; the latter being given so that the same length of bolts can be used. The number of bolts used is always divisible by four,

STANDARD DIMENSIONS FOR PIPE FLANGES

Diam. of Pipe.	Diam. of Flange.	Diam. of Bolt Circle.	Number of Bolts.	Size of Bolts for Pressures Under 75 lbs.	Size of Bolts for Pressures Over 75 lbs.	Thickness of Flange.	Thickness of Flange at Hub.	Width of Face.
Inches.	Inches.	Inches.		Inches.	Inches.	Inches.	Inches.	Inches.
2	6	4¾	4	½ x 2	⅝ x 2	⅝	1	2
2½	7	5½	4	½ x 2¼	⅝ x 2¼	11/16	1⅛	2¼
3	7½	6	4	½ x 2½	⅝ x 2½	¾	1¼	2¼
3½	8½	7	4	½ x 2½	⅝ x 2½	13/16	1¼	2½
4	9	7½	8	⅝ x 2¾	¾ x 2¾	15/16	1⅜	2½
4½	9¼	7¾	8	⅝ x 3	¾ x 3	15/16	1⅜	2⅜
5	10	8½	8	⅝ x 3	¾ x 3	15/16	1½	2½
6	11	9⅝	8	⅝ x 3	¾ x 3	1	1½	2½
7	12½	10¾	8	⅝ x 3¼	¾ x 3¼	1 1/16	1½	2¾
8	13½	11¾	8	⅝ x 3½	¾ x 3½	1⅛	1¾	2¾
9	15	13¼	12	⅝ x 3½	¾ x 3½	1⅛	1¾	3
10	16	14¼	12	¾ x 3⅝	⅞ x 3⅝	1 3/16	2	3
12	19	17	12	¾ x 3¾	⅞ x 3¾	1¼	2	3½
14	21	18¾	12	⅞ x 4¼	1 x 4¼	1⅜	2	3½
15	22¼	20	16	⅞ x 4¼	1 x 4¼	1⅜	2	3⅝
16	23½	21¼	16	⅞ x 4¼	1 x 4¼	1 1/16	2¼	3⅝
18	25	22¾	16	1 x 4¾	1⅛ x 4¾	1 3/16	2⅜	3¾
20	27½	25	20	1 x 5	1⅛ x 5	1 11/16	2½	3¾

so that the flange can be turned through an angle of 90 degrees and the holes will match. The thickness of the hub is not of so much importance and hence in extra heavy flanges, the dimensions are not given. It makes necessary, however, with long hubs, a greater length of thread on the pipe and in order for this extra length of thread to have any value, it is necessary that the threaded part of the pipe shall fit the fitting perfectly; if it does not do this, the extra length of thread may be rather a source of weakness than otherwise.

This question of pipe threads is ever an important one and no joint is properly constructed unless careful consideration is given to the manner in which the pipe is threaded. This subject is very important and the following article and illustrations were recently published by the Hartford Steam Boiler Inspection and Insurance Co., in *The Locomotive*, to bring this out more clearly and to show the many defects in pipe threads which they have encountered:

Upon the introduction of wrought-iron pipe with the taper thread, the veteran engineer Robert Briggs adopted and published a table of thicknesses and threads for various sizes of pipes and his proportions became known as the "Briggs Standard" and were adopted by most manufacturers of pipes and fittings. Its use was not universal, however, and as the pipe industry had grown to immense proportions, a uniform standard had become not only desirable but necessary. In October, 1886, the Briggs Standard was adopted by a conference of committees representing all the leading manufacturers and engineering societies and is now regarded as the national standard.

STANDARD DIMENSIONS FOR EXTRA HEAVY PIPE FLANGES

Diam. of Pipe.	Diam. of Flange.	Thickness of Flange.	Diam. of Bolt Circle.	Number of Bolts.	Size of Bolts.
Inches.	Inches.	Inches.	Inches.		Inches.
2	6½	⅞	5	4	⅝
2½	7½	1	5⅞	4	¾
3	8¼	1⅛	6⅝	8	⅝
3½	9	1³/₁₆	7¼	8	⅝
4	10	1¼	7⅞	8	¾
4½	10½	1⁵/₁₆	8½	8	¾
5	11	1⅜	9¼	8	¾
6	12½	1⁷/₁₆	10⅝	12	¾
7	14	1½	11⅞	12	⅞
8	15	1⅝	13	12	⅞
9	16	1¾	14	12	⅞
10	17½	1⅞	15¼	16	⅞
12	20	2	17¾	16	⅞
14	22½	2⅛	20	20	⅞
15	23½	2³/₁₆	21	20	1
16	25	2¼	22½	20	1
18	27	2⅜	24½	24	1
20	29½	2½	26¾	24	1⅛

The Briggs Standard thread may be described, in general terms, somewhat as follows: The threads have an angle of 60°, but are rounded off slightly at the top and bottom, so that the depth of the thread is only four-fifths as great as it would be if the threads were sharp; the outside surface of the tube is tapered to a certain distance from the end, the standard taper being such that the tube surface inclines towards the axis of the tube by 1 in 32. This makes the total taper as measured by the variation in outside diameter equal to 1 in 16, or ¾ of an inch to the foot. The total length of the tapered part is given by the empirical formula:

Length of taper $= (4.80'' + 0.8D) \div n$, where D is the actual external diameter of the tube in the straight part in inches, and n is the number of threads per inch. For example, the outside diameter of a 5-inch pipe is 5.563", so that to find the length of thread of the tapered part, we proceed as follows: $0.8 \times 5.563'' = 4.450''$, and $4.450'' + 4.80'' = 9.250''$. There

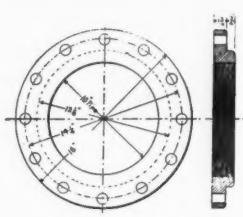

Fig. 1.—Standard

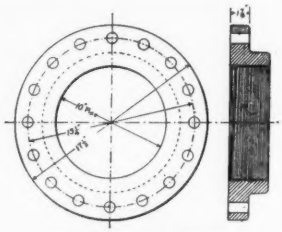

Fig. 2.—Extra Heavy

are 8 threads to the inch on pipe of this size, and hence we have finally, $9.250 \div 8 = 1.156''$, which is the length of the taper. The tapered part of the pipe is threaded with threads that are perfect at both top and bottom. Further back, beyond the perfect threads, come two threads that have the same taper at the bottom, but which are imperfect at the top. The remaining part of the screw, which consists of four threads that are imperfect at both top and bottom, is not essential to the Briggs system, but is "simply incidental to the process of cutting the thread at a single operation."

The accompanying table gives the nominal or commercial inside diameter of pipe up to 10 inches in diameter, with the actual inside and outside diameters, the thickness of metal in the body of the pipe, the length of the taper and perfect screw, the outside diameter of the thread at the end of the pipe and the diameter at the end of the pipe. These dimensions are all according to the Briggs Standard. Fig. 3 represents the standard proportions of pipe threads for a five-inch pipe except that the taper has been slightly exaggerated for greater clearness. Two threads, it will be seen, are perfect at the bottom but flat on top, and four are imperfect at both top and bottom.

The dimensions and proportions indicated in the table having been adopted by the Manufacturers of Wrought-Iron Pipe and Boiler Tubes, and also by the Manufacturers' Association of

STANDARD PROPORTIONS OF PIPE AND PIPE THREADS

Diameter of Tube.			Thickness of Metal.	Screwed Ends.		Diameter at End of Pipe.	
Nominal inside.	Actual inside.	Actual outside.		Number of threads per inch.	Length of taper and of perfect screw	Outside.	At bottom of thread.
⅛"	0.270"	0.405"	0.068"	27	0.19"	0.393"	0.342"
¼	.364	.540	.088	18	.29	.522	.445
⅜	.494	.675	.091	18	.30	.656	.579
½	.623	.840	.109	14	.39	.816	.717
¾	.824	1.050	.113	14	.40	1.025	.926
1	1.048	1.315	.134	11½	.51	1.283	1.162
1¼	1.380	1.660	.140	11½	.54	1.626	1.505
1½	1.610	1.900	.145	11½	.55	1.866	1.745
2	2.067	2.375	.154	11½	.58	2.339	2.218
2½	2.468	2.875	.204	8	.89	2.819	2.646
3	3.067	3.500	.216	8	.95	3.441	3.268
3½	3.548	4.000	.226	8	1.00	3.938	3.765
4	4.026	4.500	.237	8	1.05	4.434	4.261
4½	4.508	5.000	.246	8	1.10	4.931	4.758
5	5.045	5.563	.259	8	1.16	5.491	5.318
6	6.065	6.625	.280	8	1.26	6.546	6.373
7	7.023	7.625	.301	8	1.36	7.540	7.367
8	7.982	8.625	.322	8	1.46	8.534	8.361
9	9.000	9.688	.312	8	1.57	9.527	9.354
10	10.019	10.750	.366	8	1.68	10.645	10.472

Brass and Iron, Steam, Gas and Water Work, all pipe that is threaded at the mills of the manufacturers is supposed to be threaded according to this standard. But in shops where pipe is cut into commercial lengths, in installing new systems of piping or repairing old ones, the standard proportions of thread are not always followed. This, in fact, is but a very mild and temperate way of stating the case; for we often find that the

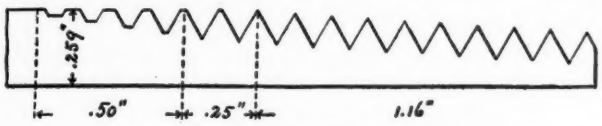

Fig. 3.—Section through a Five-Inch Pipe.

threads that are cut in such shops are so far from the standard of the fittings that they have to enter that it is impossible to make a good joint in erecting the pipe; and the result is that many lines of pipe that are now running under heavy pressure are in a condition that can be described as positively dangerous. The justice of this statement is abundantly proved by the failures that are constantly occurring at threaded joints; and if further evidence were required, a mere inspection of some of the threads that are to be found on pipes that are being made ready in these shops to go into important work, or that are taken out of such work in the course of repairs, would furnish it abundantly enough to satisfy the most incredulous.

As an example of the kind of thing that may be expected to occur, let us consider a medium size of pipe—say a four-inch one. The standard calls for eight perfect threads, then two that are perfect at the bottom and slightly flat at the top, and then four that are imperfect on both the top and the bottom; the total length that is scored by the die on the pipe being 1.8". That is what the standard calls for, as we have said; but when we come to look at the threads that are actually turned out in the shops, we find, not uncommonly, that the total length of the thread on a four-inch pipe is only 1.25", and often this is all the thread there is even on a *six-inch* pipe, where the standard calls for a total length of 2.01". Now, when a pipe is threaded in such a careless manner as that, it cannot possibly be made up into a standard fitting to the full number of threads that are called for in this system, and which are essential in order to secure the requisite strength of the joint; and we regret to say that we are constantly finding pipe connections to boilers made

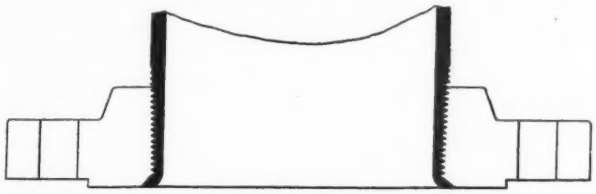

Fig. 4.—Illustrating a Peened Pipe.

with only two, three or four threads properly made up. We cannot speak too strongly against such a practice, for it shows an indifference to the safety of life and security of property that is little short of criminal. There is no excuse for it whatever, for it is easy to tell, upon looking at a pipe before the joint is made up, whether the thread upon it conforms to the standard for that size or not; and no pipe ought to be accepted that does not so conform. If a pipe has been threaded short, and then made up snug against the fitting, it is often difficult to tell, in the finished job, whether it was threaded to standard or not; but the man who puts it in has every chance to inspect it before it is made up, and there can be no excuse for his passing it if it is not right.

When many specimens of pieces of pipe in actual use are examined, some are found to be threaded too short, some do not have clean threads at all, some have threads that are wrong in shape and some do not have the proper taper and we want to say again that we can hardly find words strong enough to express our condemnation of pipe work that is done in any such bungling and reckless fashion. Too much care cannot be exercised in making pipe connections, particularly in steam pipe and boiler work, when failure is liable to cause loss of life. There is no reason whatever why a workman cannot determine at once in fitting up piping, whether or not a joint is properly put together, and whether or not it is of the strength intended for standard fitting and pipe. Some specimens show evidence that calking has been resorted to in order to make them tight. This is all wrong, for if the joint is properly made up, calking will not be necessary. The *peening* of a pipe, however, is a very different mater, and the Hartford Steam Boiler Inspection and Insurance Company recommends the peening of pipe ends, when the piping is to be used with pressures of over a hundred pounds. For this purpose a recess is formed in the face of the flange into which the pipe is screwed and the end

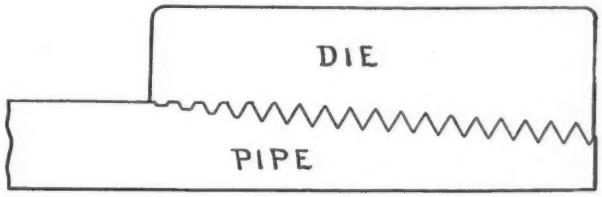

Fig. 5.—Illustrating a Completed Pipe Thread.

of the pipe, which is made a trifle long for the purpose, is peened solidly into this recess, as shown in Fig. 4; the end of the pipe being afterwards faced off. The object of this peening, however, is not to make the pipe tight, but to increase its holding power in the flange; the pipe being supposed to be made up so that there is no leakage whatever, before the peening is begun.

We have before us, a fitting and a piece of pipe which illustrate still another defect in pipe joints—a defect which is becoming increasingly common, and which should receive careful consideration by steam fitters and pipe cutters, particularly in connection with high pressures. In high-pressure work a great many constructors increase the length of the thread on the pipe to correspond with the extra heavy fittings and flanges which are then used. This is most commendable and in many places it is really necessary. It is highly important, however, that the work should be free from defects and weakness, as there is nothing gained from the extra length of thread if the joint is improperly made, and in some cases the extra length is in reality a source of weakness, as will be understood by reference to Figs. 5 to 9, which are presently to be explained. In order that the extra length of thread may be of value it is necessary that the threaded part of the pipe shall be everywhere in solid contact with the fitting; and this condition is not even approximately fulfilled by the specimen of pipe that lies before us. The first nine threads of this pipe (counting from the end) are straight, or so nearly so that no taper can be

detected by calipering. Following these nine threads are eight others that *are* in taper. It is impossible to get a good (or even a passable) joint under these circumstances. The cause of the defect, and the danger that arises from it, will be understood by reference to the diagrams.

Fig. 5 is supposed to represent a section of pipe which has been threaded to the usual length, by a die of the usual thickness. (The taper of the thread is exaggerated, in these sketches, in the interest of clearness.) The thread, when the die is in the position shown in Fig. 5, is just completed; the pipe coming through the die so as to be just flush with its outer surface. Now, if it were desired to cut a longer thread on the pipe than is shown in Fig. 5, it would be necessary either to use a die of greater length, or to run the present die further onto the pipe. The latter expedient is the one that is altogether too often adopted, the die that is used for a thread of ordinary length being merely run along the pipe until the thread is as long as desired. This method of procedure is illustrated in Fig. 6. Now it is evident that the threads that project through the die in Fig. 6 cannot have any taper. They must necessarily be straight, and of a diameter equal to the smallest diameter of the die. This fact must be carefully borne in mind in considering the sketches which follow; and to assist the eye, these straight threads have been indicated, in Figs. 6 to 9, by dotted lines.

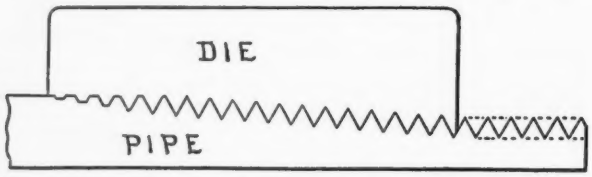

Fig. 6.—Illustrating the Effect of Running the Die too far up the Pipe.

We not infrequently find that the thread on a pipe is considerably longer than that on the fitting into which the pipe is to be made up. In this case there is neither advantage nor disadvantage (so far as holding power is concerned) in having the end threads of the pipe straight, provided the rest of the thread is standard, and the straight part is small enough in diameter to pass through the fitting, as shown in Fig. 7. More often, however, we find that the thread on the pipe has been made long because the thread in the fitting is long, and it is desired by the piper to have the thread in the pipe engage that in the fitting throughout its whole length. This excellent purpose can be readily achieved, if the die used in threading the pipe is long enough and made with the standard taper; but when the thread on the pipe has been made long by running an ordinary die further up the pipe than usual, as is shown in Fig. 6, so that there is a straight part at the end, the pipe will necessarily "make up" into the flange somewhat as represented in Fig. 8. It is here supposed that the straight part of the pipe thread (indicated by the dotted line) is just of a size to fit the small end of the fitting perfectly. In that event, and assuming also that the taper on the pipe and the fitting is the same, it is manifestly impossible for the threads in pipe and fitting to fit one another properly, anywhere except for a couple of threads at the small end of the fitting. Owing to the fact that the last threads on the pipe are imperfect (or should be), it is quite possible that one or two of the perfect threads at the large end of the fitting will touch the pipe in the manner indicated on the left of Fig. 8; but it is plain that a contact of this kind adds nothing to the holding power of the joint. In fact, in a case such as is shown in Fig. 8, the strength of the joint consists of nothing whatever save the few threads that bind where the straight part of the pipe enters into the smallest part of the fitting.

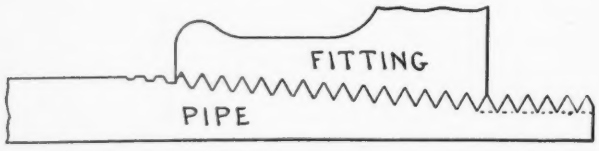

Fig. 7.—Illustrating a Pipe Projecting through the Fitting.

The theory of the taper thread in pipe work is, that in making up the joints there is just enough difference in the gauges of the fitting and the pipe to permit of the joint coming together so as to bring all the threads into good, compressive contact throughout the whole length of the joint. In this manner a uniform strength and holding power are obtained through every thread in the fitting; and with a heavy fitting and an extra length of *standard* thread, the joint becomes correspondingly stronger. But when the pipe thread is straight for a certain distance at the end, so that the condition of joint shown in Fig. 8 is inevitable, and only two or three threads or, at most, four threads are in good contact in the entire length of pipe, the conditions are very different. The joint is deficient in holding power, and the threads that are in contact, being insufficient to hold the strain, are very likely to strip and withdraw, the load being thus thrown upon the next few threads; and these, since they will fit each other very poorly, are less strong than the original ones, and the joint presently fails, very likely with disastrous consequences. This action is greatly facilitated by the vibration which is universal in pipe lines and boiler connections, this vibration causing the threads to abrade and loosen. These dangers are not imaginary in the least and we have met with many cases of pipe failure, in the past few years, from the very causes here explained.

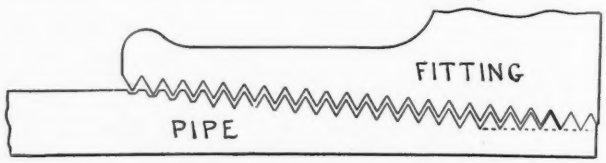

Fig. 8.—Illustrating an Imperfect Pipe Joint.

Sometimes pipe is threaded in such a manner that its end threads are straight for the reason illustrated in Fig. 6, while its tapered part makes a greater angle with the centre line of the pipe than the standard calls for. In this case the pipe may fit the fitting at each end, while departing from it materially in the middle, as is illustrated in Fig. 9. A hold such as is shown in

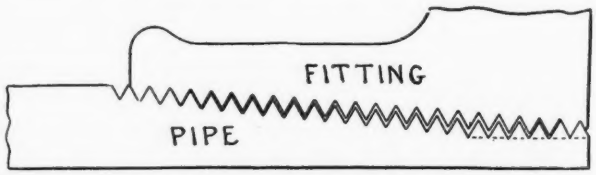

Fig. 9.—Illustrating an Imperfect Pipe Joint.

Fig. 9, while undoubtedly wretched and dangerous, is nevertheless, slightly better than that shown in Fig. 8, since more of its threads are properly bottomed, and it is also more solid, and therefore less liable to suffer from vibration.

In conclusion, let us say that all pipe that is to be used in steam, water and gas fitting should be of standard size, standard thickness and standard thread, and should be round and straight. All fittings (unless made of malleable iron or steel, which would be preferable but more expensive) should be of heavy gray iron castings, with heavy beads, and with clean, full threads, tapped to standard gauge; and for high pressure service (100 pounds and over), the fittings should be extra heavy fittings, of the standard adopted by the American Society of Mechanical Engineers; the threads being cut actually and accurately by the Briggs Standard in taper and gauge, but of the increased length required by the heavier fittings and flanges. The depth of thread in the fittings should also receive the consideration that it requires, in order that the extra length of thread on the pipe itself may be engaged throughout its entire length.

THE SUPERHEATED STEAM PROBLEM

Some Advantages of the Use of High Temperature Steam

The problem of whether it is economical to use superheated steam in a reciprocating engine has been one which has been discussed pro and con for many years. The result has usually been that if the disadvantages, when weighed on the engineering balance, have exceeded the advantages, for any given plant, superheated steam has not been used, but if the use of the high temperature steam has the balance in its favor, then the superheater is used.

Superheated steam is used because there is always a loss of heat from steam pipes and the heat so lost represents an equivalent condensation when the pipe conveys saturated steam. Superheated steam cannot condense; it must first lose all of its superheat and be reduced to saturated steam. In consequence, if sufficiently superheated it can lose the amount of heat represented by radiation from the steam pipes, yet reach the engine perfectly dry. Since the thermal conductivity of superheated steam is less than that of saturated steam, the heat will not be so rapidly transmitted from the body of the steam to the walls of the pipe.

Another important reason for using superheated steam is to overcome the effects of initial condensation in the cylinder. Since at each stroke the entering steam must warm up the cylinder from the exhaust temperature to the temperature of the entering steam, some of the steam would condense if it entered the cylinder in a saturated condition. The amount thus condensed is usually about 20 to 30 per cent. of the total weight of steam entering the cylinder. It is therefore obvious that if an amount of heat more than sufficient to warm the cylinder walls could, by means of superheating, be imparted to the steam before it reached the engine, then even after the cylinder walls had been warmed up, the steam would remain dry and the initial condensation would thus be overcome.

These properties of superheated steam had long been known as early as 1857 and between that year and the year 1870, superheated steam was used in various European countries. After the latter year it was abandoned for some length of time because it was found that if the superheating was carried beyond a certain point, the valves and cylinders of the engines were liable to become corroded. This was probably due to the use of animal or vegetable oils which are decomposed at high temperatures and chemical changes take place which corrode the metal of the valves and cylinders. Another trouble experienced was in the construction of the superheater. Owing to the low thermal conductivity of superheated steam, the tubes of the superheater were frequently burnt out when exposed to the hot gases of combustion and great difficulty was experienced in keeping the joint tight.

Superheated steam is steam whose temperature exceeds that of saturated steam of the same pressure and it is produced by adding additional heat to saturated steam which has been removed from contact with the water from which it was formed. For instance, according to the accompanying table, saturated steam at a gauge pressure of 100 pounds, which is approximately 115 pounds absolute, has a temperature of 337.9 degrees. This is a fixed temperature for that pressure and the temperature can never be higher so long as this steam is in proximity to the water. If, however, the steam is isolated and then heated, its temperature will rise and it will become super-

Steam Table.

Absolute Pressures	Temperatures	A	B	A + B	Volume of one Pound	Weight of one Cubic Foot
		Sensible Heat, or Heat of the Liquid.	Latent Heat, or Heat of Vaporization.	Total Heat from Water at 32°		
Lbs.sq.in.	Fahr.	Units of Heat per lb.	Units of Heat per lb.	Units of Heat per lb.	Cubic Feet.	Pounds.
1	102.	70.	1043.	1113.1	334.6	.003
2	126.3	94.4	1026.1	1120.5	173.6	.0058
5	162.3	130.7	1000.8	1131.5	73.22	.0137
10	193.3	161.9	979.	1140.9	38.16	.0262
14.7*	212.	180.8	965.8	1146.6	26.64	.0376
20	228.,	196.9	954.6	1151.5	10.91	.0502
25	240.	209.1	946.	1155.1	16.13	.0620
30	250.3	219.4	938.9	1158.3	13.50	.0736
35	259.2	228.4	932.6	1161.	11.75	.0851
40	267.1	236.4	927.	1163.4	10.37	.0964
45	274.3	243.6	922.	1165 6	9.287	.1077
50	280.9	250.2	917.4	1167.6	8.414	.1188
55	286.9	256.3	913.1	1169.4	7.696	.1299
60	292.5	261.9	909.3	1171.2	7.096	.1409
65	297.8	267.2	905.5	1172.7	6.583	.1519
70	302.7	272.2	902.1	1174.3	6.144	.1628
75	307.4	276.9	898.8	1175.7	5.762	.1736
80	311.8	281.4	895.6	1177.	5.423	.1843
85	316.	285.8	892.5	1178.3	5.125	.1951
90	320.	290.	889.6	1179.6	4.858	.2058
95	323.9	294.	886.7	1180.7	4.619	.2165
100	327.6	297.9	884.	1181.9	4 403	.2271
105	331.	301.6	881.3	1182.9	4.206	.2378
110	334.6	305.2	878.8	1184.	4 026	.2484
115	337.9	308.7	876.3	1185.	3.862	.2589
120	341.1	312.	874.	1186.	3.711	.2695
125	344.1	315.2	871.7	1186.9	3.572	.2800
150	358.3	330.	861.2	1191.2	3.011	.3321
175	370.7	343.	852.	1195.	2.603	.3841
200	381.7	354.6	843.8	1198 4	2 294	.4359
225	391.8	365.1	836.3	1201.4	2.051	.4876
250	401.	374.7	829.5	1204.2	1.854	.5393

* Atmospheric pressure.

heated. If, say, the above-mentioned steam was raised to a temperature of 400 degrees, then the steam would have 400 — 337.9, or 62.1 degrees superheat.

Superheating should not be regarded as a means of carrying more heat to an engine, but only as a preventive of waste through condensation. It has been proven by experiment that about 8 degrees of superheat are required to prevent each one per cent. of moisture in the cylinder at cut-off when using saturated steam. If the specific heat of superheated steam at constant pressure be taken as 0.48, it follows that a rise of 8 degrees in the temperature above the normal temperature of saturated steam of the same pressure represents the expenditure of $0.48 \times 8 = 3.84$ British Thermal Units. Assuming the initial condensation of the entering steam to be about 20 per cent., then $3.84 \times 20 = 76.8$ British Thermal Units must be added in the form of superheat to insure dry steam at cut-off.

The amount of fuel required to superheat steam, and the quantity of fuel that must be burned to produce this heat, are greater than is commonly supposed. It takes, as will be noticed in the steam table, approximately 1100 British Thermal Units to convert a pound of feed water at ordinary temperatures into steam at the usual temperature. By the addition of 76.8 British Thermal Units in the form of superheat, we have increased the expenditure of heat by about 7 per cent. If all the 20 per cent. of condensation is saved there is undoubtedly a decided gain, and this fact is true that a small amount of superheat is desirable in all forms of engines. It is in the higher degrees of superheat that this difference vanishes because the specific heat of superheated steam increases with the degree of superheat.

The specific heat of superheated steam at atmospheric pressure and near the point of saturation was found by Regnault to be 0.48 and until recently this value was thought to apply to the specific heat at higher pressures. Recent investigations, however, have shown that the specific heat is not constant, but that it is approximately 0.65 for 100 degrees superheat, and 0.75 for 200 degrees superheat. Using these values, it can be calculated that the fuel used to generate saturated steam must be increased by the following percentages in order to superheat the steam to the various degrees named:

Degree of Superheat.	Additional Fuel Needed.
75°	5 per cent.
100°	7 " "
150°	11 " "
200°	15 " "
250°	20 " "

Whether, therefore, it is advisable to superheat the steam and increase the fuel consumption or whether it is best to use saturated steam is nowadays a problem of finance rather than of engineering.

The most important disadvantage which superheated steam has had, when used in a reciprocating engine, has been the difficulty of lubrication. This disadvantage does not hold in the steam turbine and it appears that in this class of engine superheat will find its field of greatest usefulness. It is said that one of the greatest losses of efficiency in the steam turbine is the friction between the wheel and casing caused by a film of water and also by the drops of water falling on the disc and flying away from it again, and it is for this reason that superheated steam, which contains none of this moisture, is used extensively in turbine practice.

Riveted Steel Hydraulic Pipe.

Riveted steel pipe, because of its lightness, great tensile strength and cheapness of manufacture, is used quite extensively in the Pacific Coast States for hydraulic purposes. It is protected from corrosive agencies by dipping in a hot bath of asphaltum. The smaller sizes of pipe are made of taper courses, like stove pipes, while the larger sizes are usually made of cylindrical courses, alternately large and small. The pipe is made into convenient lengths, varying from 16 to 30 feet.

The slip joint, which is made up of the taper courses, possesses the advantages of cheapness, and facility in laying. While seldom used where tight joints are desirable, they can be made absolutely tight when sufficient care is taken in joining the pipes together. One end of each length being smaller than the other end permits the pipes to be driven together. To secure the best results, two methods are recommended.

1. Preliminary to joining the pipes, coat the interior of the large end with kerosene or gasoline and set fire with a match. This will serve the double purpose of melting the asphaltum and expanding the end of the pipe. The pipes should then be driven together tightly, either with a heavy ram suspended from a derrick or with a sledge hammer. A heavy block should be placed over the end of the driven pipe to receive the blows. The subsequent shrinking of the outside pipe and the hardening of the asphaltum combine to make a tight joint. Care should be taken in driving pipes of light gauges, for if the blows are too heavy, there is danger of buckling the pipe.

2. The second method requires that the diameter of the large end of each length be increased sufficiently to permit the small end to be wrapped with a narrow strip of thin sheet lead. After the joint is driven it may be made absolutely tight by calking the lead with a thin calking tool. Burlap dipped in tar or liquid asphaltum is sometimes used as a substitute for sheet lead.

The riveted form of joint is used for permanent pipe lines 20 inches or more in diameter. Cold rivets are used for light gauges and hot rivets for the heavy gauges. The straight seams are double riveted and the round seams which connect the courses are single riveted. For convenience in transportation, the courses are punched and rolled only and riveted together at their destination.

———o———

Properties of Fire-Clay.

Fire-clay is never used as a cement, as it has little binding power. Its principal use is to fill in the spaces between the bricks and no more should be used than necessary. The proper way to mix the clay is to a thinness so that a trowel cannot be used but the brick should be dipped into the clay, rubbed and shoved into place and driven with mallet, or hammer and block, until it touches the brick next to it. This especially applies to fire-brick arches. Fire-clay should not be depended upon other than to fill empty spaces, because it shrinks during drying and lacks cementing power. Shrinkage may be lessened by mixing with the clay about 20 per cent. of pulverized fire-brick sifted very fine. Its cementing power may be increased by adding to it $^1/_{100}$th part of its volume of lime. This will have just sufficient fluxing power to unite with the clay and take a grip on the fire-brick. This mixture should always be used when building arches.

The Power Station of the Paris Subway Electric Railway

By Frank C. Perkins.

The greater part of the Paris-Orleans Railway between Quai d'Orsay and the Austerlitz station is of underground construction. This section of the railway is operated electrically on account of the great length of time steam locomotives would be required in the terminal station, thus causing great difficulty in the ventilation of the station and the underground section of the line. At the Austerlitz station the electric locomotives are taken off and steam locomotives provided, the stop required being less than two minutes, and causing no inconveniences or interferences with the service when the train is leaving Paris. The trains entering Paris are provided with electric locomotives for hauling through the subway and into the station.

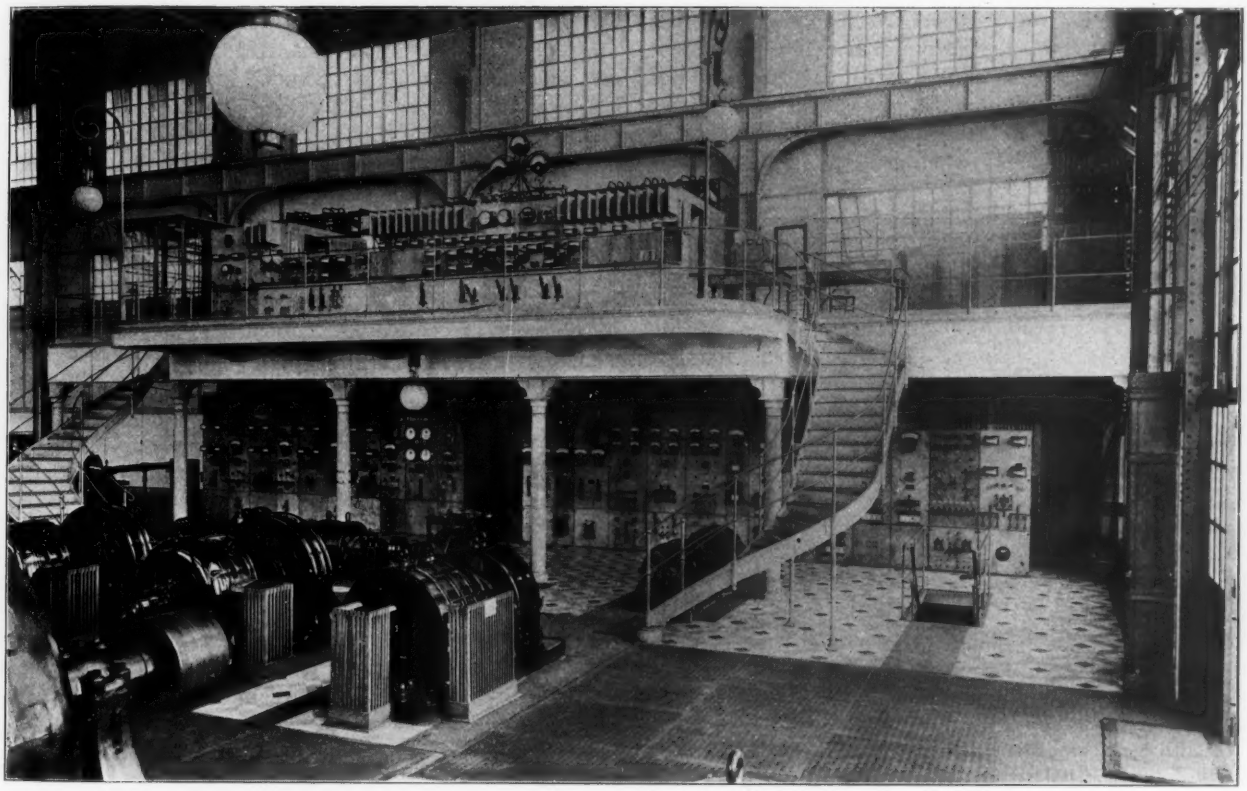

Fig. 1.—Interior of the Paris Subway Power House showing Switchboard, Motor-Generators and Rotary Converters.

The power station is located at Ivry, near the "Pont de Tolbiac," a distance of 5350 meters from Orsay. The electrical energy produced at this power house not only supplies current for electric traction between the station of Austerlitz and the Quai d'Orsay, but it is also utilized for lighting purposes as well as for numerous small motors. The electric current generated is three-phase, having a frequency of 25 cycles per second and a pressure of 5500 volts. The alternating current is utilized only for the lighting and small motors, it being transformed to a direct current at two substations for traction service. The two substations are located at Orsay and Austerlitz, the three-phase current being changed from 5000 volts at 25 cycles to 550 volts continuous current, for the electric traction. A large storage battery installation has been provided at each sub-station, which is normally in the traction circuit but which can also be utilized for lighting.

As shown in the illustration on front cover, there are three alternators installed in the power house, each having a capacity of 1000 kilowatts. These machines are directly coupled to horizontal triple expansion Corliss engines having a capacity of 1500 horse power normal, at a speed of 75 revolutions per minute, with a maximum output of 1700 horse power. Each engine and generator is provided with a fly-wheel weighing 100,000 pounds and arranged so as to exhaust into the air or into a condenser, as desired, the latter being placed underground below the engine. A vertical high speed engine of 35 horse power capacity, and another of 70 horse power capacity are utilized for driving the exciters supplying direct current to the fields of the alternators. The accompanying illustration, Fig. 1, shows the switchboard, motor-generators, and rotary converters installed in this power station.

The boiler house, as shown in Fig. 2, is equipped with multitubular boilers having automatic stokers with pipes conveying the fuel directly to the hoppers in front of the boilers. These boilers have a heating surface of 186 sq. meters and are ar-

ranged in two batteries, being combined with a set of economizers of 400 sq. m. heating surface, which reheat the feed water by means of the hot gases escaping to the chimney. The boilers are fed with water in two separate and distinct ways. In the first place, by means of pumps, operated by the engine and connected with the condenser and, secondly, by two direct-acting steam pumps. There are two smoke stacks each 8 feet in diameter at the top and about 250 feet high, the economizers, one of which has about 450 tubes and the other about 400 tubes, raise the temperature of the feed water to over 100 degrees C. Electrically operated conveyors, elevators, and stokers are utilized, the coal being fed to the boilers and the rate of combustion being regulated according to the load on the engines. A horizontal and vertical conveyor automatically takes the cinders from the grate and loads the same upon the cars.

In the engine and generator room there are also provided motor generators and rotary converters, supplying the necessary current for the storage battery installation as well as for transforming the alternating current to a direct current of 500 volts for traction service. The two sub-stations at Austerlitz and Orsay are divided into two parts, one of which supplies current for lighting and the other part for electric traction.

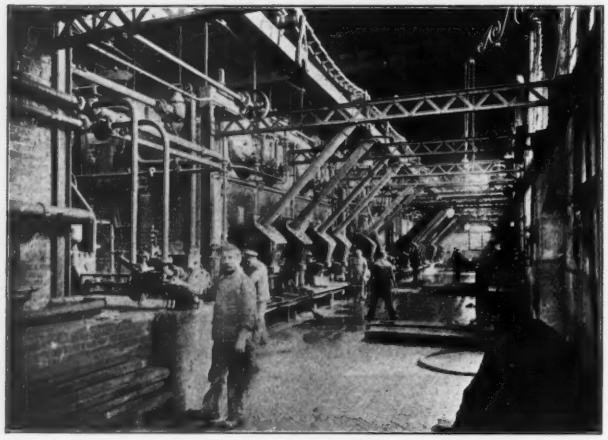

Fig. 2. Boiler Room of the Paris Subway Power Plant

There are two motor generator sets of 100 kilowatts each and two equalizer sets; also two rotary converters of 250 kilowatts capacity and six static transformers of 90 kilowatts capacity each. The transformers are of the air-cooled type, reducing the 5500 volt three-phase current of a frequency of 25 periods per second to a pressure of 340 volts, while the 250 kilowatt rotary converters receive this current and operating at a speed of 750 r. p. m. supply a direct current of 500 volts to 575 volts to the railway feeders. The storage battery has a capacity of 1100 ampere-hours. At the Orsay station there are two rotary converters of 250 kilowatts, each with the necessary step-down stationary transformers and a storage battery of 290 elements having a capacity of 650 kilowatts at one hour discharge. There is a third sub-station at Ablon, having two rotary converters of 500 kilowatts each and one similar machine of 250 kilowatts capacity, together with a storage battery capable of supplying 900 kilowatts. The current for operating the electric trains is supplied by the sub-stations to the third rail of the track at from 500 to 575 volts pressure, the third rail weighing 54 kgs. per meter and of the Vignole section. The distance from the Austerlitz station to Juvisy is a trifle less than 12 miles and the distance from Austerlitz to the Orsay terminal is less than 3 miles, or a total of somewhat less than 15 miles. There is a track on each side of the main line which is electrically equipped, suburban trains being operated thereon. There are about 200 trains leaving and arriving at Paris on the Orleans line each day hauled by electric locomotives along the river Seine, between the Orsay and Austerlitz stations. There are over 70 suburban trains which retain the electric locomotive for a distance of 12 miles between Austerlitz and Juvisy, the steam locomotives hauling the regular main line trains. The eight old type of electric locomotives are somewhat similar to the Lockport and Baltimore and Ohio electric locomotives, while the new locomotives are of the motor car construction type, five of these locomotives utilized having two motor trucks, each of which has two General Electric motors, the output being 270 horse power. The locomotives first installed had gear reduction ratio of 1 to 2.23 and were capable of operating at a speed of 60 miles per hour without load and 45 miles per hour hauling a train of about one million pounds.

The new locomotives weigh over 100,000 lbs., measuring over 11 meters in length, the car body having a total length of over 10 meters. The ratio is the same as that mentioned above, the wheels utilized having a diameter of 1.245 meters. These motor cars are operated on the multiple unit control system with four motors of 125 horse power capacity. The total distance from Austerlitz to Juvisy, about 12 miles, is made with a train of 890,000 lbs. in a quarter of an hour, without stops, two of these motor cars being utilized with each train, which is handled from each of the motor cars compartments. The motor cars also have space for passengers as well as for baggage, the cabs for the motormen being located at each end. The motor cars weigh 50 tons, those being used by passengers having a total length of body of over 16 meters and a total length over all of 17 meters. These cars have a gear reduction of 1 to 3.08 and are provided with wheels 1060 mms. in diameter. The new electric locomotive cars as well as the new passenger motor cars are equipped with automatic brakes, of special construction, while fire-prooof material has been utilized in their construction in order to avoid all possibility of fire.

Shutting Down Alternators.

In shutting down an alternator, the field rheostat should be turned so as to include all the resistance in the circuit, then the exciter field rheostat should be turned so as to include all the resistance. This lowers the voltage as much as possible. The alternator main switch may be opened if the alternator is to continue running. If, however, the alternator is to be stopped, the switch should not be opened until the machine comes to rest.

In order to reverse the direction of rotation of a motor, a single rule should be borne in mind, namely, the current in either the field or the armature must be reversed. If the current in both field and armature be reversed simultaneously, the direction of rotation of the motor remains unaltered.

TREATMENT OF PISTON ROD PACKINGS

Methods Necessary to Obtain the Best Results

By E. H. Naylor.

How often some one is heard saying: "What has got to be trouble with packings of late?" or, "For the last year or two I cannot get anything to stay on my rods," or, "This packing will not run on the new engine as it did on the old," and numerous other remarks on the same subject. Now, I think if some engineers would only stop and think for a few minutes they might see some cause for these.

Conditions are not the same to start with or there would be no trouble, because if the conditions were just the same and the packing just the same, I see no reason why the same kind should not give just as good results as it did in the old plant. If, however, the plant is built over and a larger engine installed and perhaps a different type of engine, it may require some other packing to get the desired results.

All packing cannot be treated alike; some expands considerably while others have very little expansion. Some packing will expand wholly between the stuffing box and the rod, while other kinds will expand almost entirely along the rod.

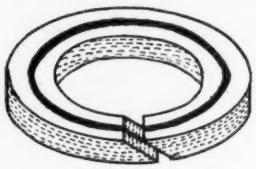

Fig. 1.

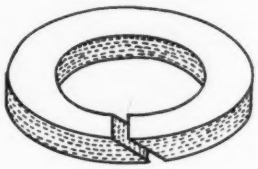

Fig. 2.

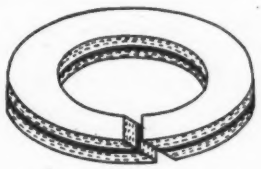

Fig. 3.

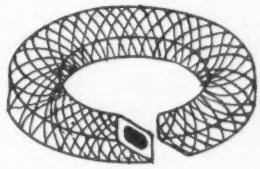

Fig. 4.

The packing shown in Fig. 1 is sure to expand from the rod against the walls of the stuffing box because the strip of rubber in the centre of the ring is sure to cause the packing to open up and allow very little expansion with the rod. Fig. 2 is just the reverse of Fig. 1.

The expansion of the packing as shown in Fig. 3 is practically the same as that shown in Fig. 2, because the packing is made in sheets and then cut to the sizes required. It is made on the same principle as fibrous pump packing, only more rubber is between each layer of cloth or canvas, as you may wish to term it. When a packing of this kind is cut for a stuffing box, it must be made a neat fit on both rod and stuffing box, and when a supply is put in, all the old packing should be taken out and replaced with new. A box should be filled only about two-thirds full so that it will have room to expand and when the packing has all been placed with the joints staggered, just push the gland up to the packing and turn the nuts on the bolts with the fingers and no more, because, in placing this packing ring by ring, it should be pushed home, but do not attempt to drive it too solid. One reason why the nuts should be only finger tight is because as the packing becomes warm the nuts will have to be eased until the proper place is found where there is the least friction and still be steam tight. Fig. 2 is treated practically the same as Fig. 3 because it is made on the same principle.

In placing a new supply of packing, as shown in Fig. 1, it is necessary to have the ring cut just the opposite to the packings shown in Figs. 2 and 3. Instead of a neat fit, it should be an exact fit on the rod and an easy fit in the stuffing box because the expansion is between the rod and the box, as stated above. This packing should be placed in the stuffing box in the same way as described above and then the nuts placed on just finger tight. This style of packing will not require so much backing off of the nuts as when packings shown in Fig. 2 and Fig. 3 are used, but it will require some.

I have used this kind on several engines and while one packing lasted just one year on one engine, when used on a larger one of the same make, it would only last from six to eight weeks. The packing was treated alike in both engines in every respect but in the larger engine, the packing would crumble. The smaller engine was a 12 x 30 running at 110 revoltuions, while the larger one was an 18 x 32 running at 100 revolutions with the same steam pressure.

In the larger engine I have had to use a ring, as shown in Fig. 4. The expansion in this ring is in all directions, due to the round rubber core. Care must be taken to have the rings made a proper fit or trouble may be expected. If not treated and watched for the first week or so, hot rods may result from it. It must be treated somewhat like the other packings but a little cylinder oil should be often dropped on the rod or it will give more or less trouble. This style of packing is liable to become hard and may do damage if not cared for, as it is made of asbestos and is called high pressure packing, while the other packings shown, if kept just steam tight without the nuts being set up too hard, will waste away in a kind of soft pulpy mass.

Good results are never attained by setting up hard on the gland nuts, for if steam is stopped blowing, it is only temporary and in a short time the operation has to be repeated which often results in a scored or fluted rod. Rods wear very fast with this treatment and the packing soon becomes very hard.

If a packing blows some for a while after just starting up, it is not the proper thing to set up on it, because as soon as it becomes thoroughly warmed up, it will be sure in almost all cases to take up, unless it is old and worn. I have often heard engines pounding and the engineer would say that he does not understand why it should because he had keyed it up as close as he dared. When, however, they have learned the lesson to do away with all the friction on the piston rod, it is possible that the pound will have disappeared.

It is not always lost motion or lack of proper compression that causes pounds in engines, but often the piston rod pack

ing has considerable to do with it. For an illustration, set up on the valve rod packing on a slide valve engine and, as you are setting up on it, notice the change in the sound. It will only be a short time, perhaps a minute or two, until there can be heard a strong chucking sound; so in setting up on piston rods, the engine is made to pound in the same way the valve stem was made to pound.

All packings have their peculiarities and to get the results expected, we must study their good points and faults, just as much as we do our engines, pumps, and other machinery. If this would be done, I think there would be less trouble with rod packing, for then the proper packing would find the proper place and the condition to suit it.

TRANSMISSION ROPE SPLICING

A Description of the Method of Making the English Splice

Among the various methods of transmissions of power, the rope drive is quite attractive for certain purposes. Gearing, belting, and electric drives have all been used extensively but it has not been until the last few years that the use of ropes as a means of transmitting power has received the general recognition of mill engineers in this country, although in England it has been used for some time. In this country some of its important applications can be seen in the grain elevators along the Great Lakes, in the steel and tin plate industries of the Middle States, and in the textile mills in both the North and South.

The three kinds of rope most generally used are wire rope, cotton rope, and manilla transmission rope. The manilla transmission rope is the one in most common use for all kinds of drives since it has a high strength, can be easily spliced, and is self-lubricating. It is usually made with three, four, or six strands, the four and six strand ropes having an inner core or heart, around which the outer strands are laid.

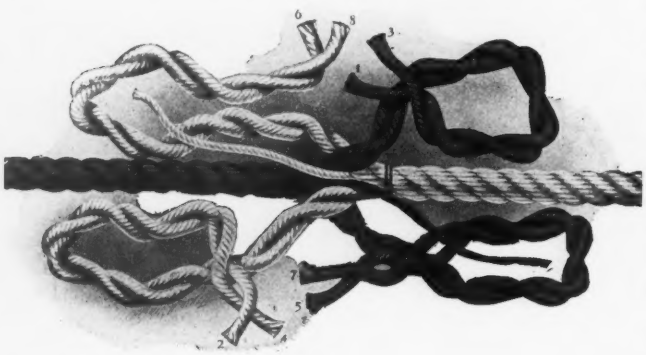

Fig. 1.

The value and life of a transmission rope depend to a large extent upon the manner in which the splice is made. By permission of the American Manufacturing Company we are able to describe a method for splicing ropes which is taken from "The Blue Book of Rope Transmission," published by them.

If the researches of their engineer have developed nothing else, they have shown beyond all question that at least ninety-five per cent. of the "troubles" complained of in rope drives are directly caused by bad splicing and they give the following method as being the best one known:

"The essential points in a transmission splice are: First, that its diameter be absolutely the same as that of the original rope; secondly, that it be smooth and free from lumps; thirdly, that the original lay of strands and yarns be disturbed as little as possible; and fourthly, that where the several strands are joined, each fastening or 'tuck' should be made in such manner as to prevent its wearing away and the rope unstranding.

"There are many different splices now in use, but after a careful consideration of each we are convinced that all the above features are combined only in what is called the English transmission splice, and experience has proved it the best splice now known.

Fig. 2.

"In describing this, we take for our example a four-strand rope, 1¾-inches diameter. The rope is first placed around sheaves, and, with a tackle, stretched and hauled taut; the ends should pass each other from six to seven feet, the passing point being marked with twine on each rope. The rope is then slipped from sheaves and allowed to rest on shafts, to give sufficient slack for making splice.

"Unlay the strands in pairs as far back as the twines M, M', crotch the four pairs of strands thus opened (Fig. 1), cores having been drawn together on the upper side. Then, having removed marking twine M, unlay the two strands 6 and 8, still in pairs, back a distance of two feet, to A, Fig. 2; the strands 1 and 3, also in pairs, being carefully laid in their place. Next unlay the strands 5 and 7 in pairs to A', replacing them as before with 2 and 4. The rope is now as shown in Fig. 2.

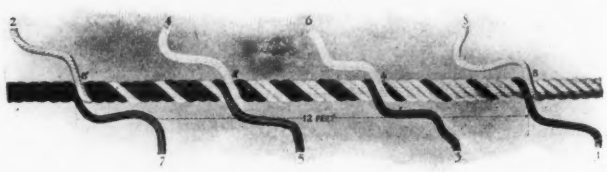

Fig. 3.

"The pair of strands 6 and 8 are now separated, and 8 unlaid four feet back to B, a distance of six feet from the centre, strand 6 being left at A. The pair of strands 1 and 3 having been separated, 3 is left at A, as companion for 6, strand 1 being carefully laid in place of strand 8 until they meet at point B.

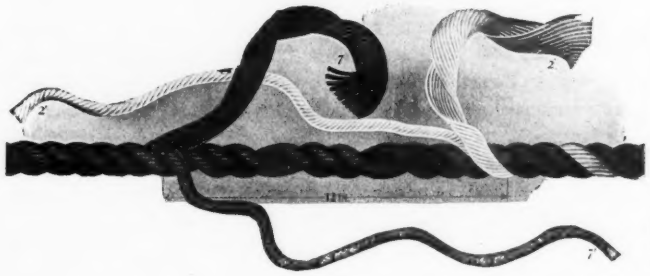

Fig. 4.

"The two pairs of strands 2-4 and 5-7 are now separated and laid in the same manner, every care being taken while thus putting the rope together, that original twist and lay of strand is maintained. The protruding cores are now cut off so that the ends, when pushed back in rope, butt together.

"The rope now appears as shown in Fig. 3, and after the eight strands have been cut to convenient working lengths (about two feet), the companion strands are ready to be fastened together and 'tucked.' This operation is described for strands 2 and 7, the method being identical for the other three pairs.

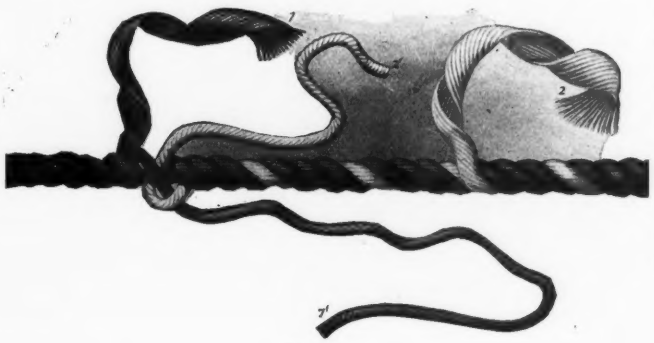

Fig. 5.

"Unlay 2 and 7 for about 12 to 14 inches, divide each strand in half by removing its cover yarns, as shown in Fig. 4. Whip with twine the ends of interior yarns 2′ and 7′; then, leaving cover 2, relay 2′ until near 7 and 7′, here join with simple knot 2′ and 7′, as shown in Fig. 5.

"Divide cover yarns 7, and pass 2′ through them, continuing on through the rope *under* the two adjacent strands, avoiding core, thus locking 2′, as shown in Fig. 6. *In no event pass 2′ over these or any other strands.*

"Half strand 7′ must now be taken care of; at the right of the knot made with 2′ and 7′, 2′ is slightly raised with a marlin spike, and 7′ passed or tucked around it two or three times, these two half strands forming in this way a whole strand. Half strand 7′ is tucked until cover 2 is reached, whose yarns are divided and 7′ passed through them and drawn under the two adjacent strands, forming again the lock. The strand ends at both locks are now cut off, leaving about 2 inches, so that the yarns may draw slightly without unlocking. This completes the joining of one pair of strands, as shown in Fig. 7. The three remaining pairs of strands are joined in the same manner.

"After the rope has been in service a few days, the projecting ends at locks wear away, and if tucks have been made carefully, and original twist of yarns preserved, the diameter of the rope will not be increased, nor can the splice be located when rope is in motion."

Oil in Boilers.

A paper was recently read before the Northeast Coast Institution of Engineers and Shipbuilders of England, by Mr. D. B. Morison, in which he said that if the surface of a furnace

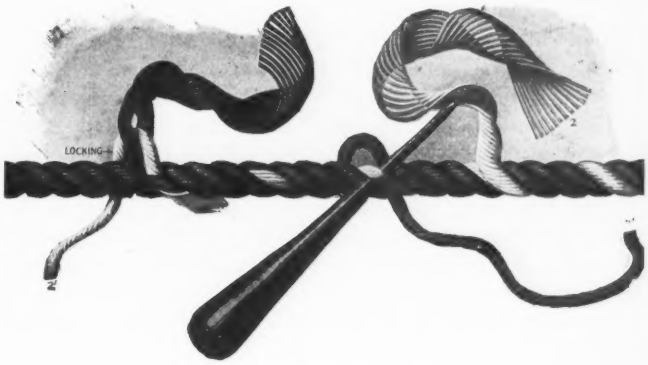

Fig. 6.

in a boiler, for, say, 200 pounds pressure, were clean, the temperature of the metal would never reach the point at which its original tensile strength would be appreciably reduced, even under very high rates of evaporation. If, however, the surface were simply rubbed over with a very thin coating of mineral oil, the temperature would at once rise to over 650 degrees, even with a moderate rate of evaporation. An appreciation of this fact would explain many a so-called mysterious collapse of apparently clean boilers. A disastrous accident of this nature came under his notice some time ago, in which the fur-

Fig. 7.

naces of a passenger steamer collapsed in mid-ocean. The boilers were apparently clean, with no appreciable scale on any part, and the principal cause of the accident was the use of a very inferior oil for swabbing the rods and lubricating the auxiliary engines. The oil became emulsified with the feed water, and being therefore unfilterable, passed into the boilers and was deposited on the metal.

The Organization of Working Forces in Large Power Houses

Mr. W. P. Hancock, of the Boston Edison Electric Illuminating Co., recently read a paper before the National Electric Light Association on the organization of the working forces in large power houses so that the best results can be obtained. The following description of the duties required of the different men going to make up the organization of a large plant will give to the engineers a chance to see themselves as others see them and should better enable them, even if they work in small plants, to aspire to those things which mean promotion or perhaps larger jobs. Mr. Hancock divides the men and their duties as follows:

Steam Division.—The chief engineer of the steam system is, of course, totally responsible to the head of department, or his representative, for the good and economical operation of that system; and in order to be able to assume that responsibility in a manner favorable to the company's interest, and with success for himself, he must have among his various accomplishments a few which I will mention, and which I claim are extremely important.

We will assume that he came to us with the necessary license, that he has had a good and varied experience with steam engines and auxiliaries and is a first-class mechnic. Perhaps we know him by reason of his having been employed on a nearby system for some time, and, if this be the case, we have had the opportunity to see what kind of an organizer he is, what his judgment is in the hiring of men, whether he has the ability to maintain discipline among his men and takes an interest in knowing whether or not it is maintained, and whether he plans the work of his system and passes his orders to his first assistant, to be passed by him down the line, in such a way as to avoid the bad complications caused by conflicting orders given by himself and his first assistant to a watch engineer, perhaps to others of his organization. We can see whether he has favorites among his men by reason of earlier acquaintance with them; if he has and it is apparent, we know there is trouble ahead. We can see what his inclination is when the load is going at the beginning of the summer and the pay-roll will stand a reduction, not in the rate of wages but in number of men employed. We can see whether or not he has the "hustle and push" to put the system on its feet and keep it there, without having to be reminded that it is for that purpose that he is drawing his salary; also if he takes a keen interest in matters to such a degree that if he doesn't hear from certain items in his system he will go after such items and not take it for granted that they are all right or he would have heard from them.

If arguments arise between any of the men and their superiors, does he act absolutely on his best judgment, or does he allow it to be warped because the man who is in trouble with his watch engineer is an old man—not in years, but on the system—and he thinks that man cannot do wrong? If he does favor the man at such a time and the man has done something irregular, he will make the mistake of all his time on that system, with reference to discipline and organization. He will regret that decision for a long time to come, for then and there the man in the ranks practically becomes licensed to disobey his superior next above him, and that fact is very soon known among the men in his and other lines of work on the steam system; the watch engineer is thereafter ignored to a degree by the men over whom he is in charge, and he is not to blame if he leaves his position, rather than lose his reputation that he may have earned by his ability to work his watch successfully and to the interest of his employer.

It is the business, and a valuable part of the business, of the chief engineer to administer in such cases in a manner that is just to all concerned, from the interests of his employer down to the interest of the man who was disobedient, and also in such a manner as will preserve the dignity of his position and, at the same time, by reason of just decisions, retain the respect of his total organization. He should administer justice without fear or favor, and while the way may be rough for a while it will assuredly smooth itself in due season; and what could be more satisfactory to the head of the steam division than the positive assurance that his assistants and men were working in harmony for their own interest, for his interest, and for the interest of their employers?

I claim that if the head of a steam division has not the ability to take care of these matters on these lines, the organization will be far from satisfactory from the standpoint of good service and economy. Almost any chief engineer can continue to hire and discharge men at short intervals and claim that as his only alternative; but if he does, it is a loss to his employers.

First Assistant Engineer.—The engine-room is in the immediate charge of the first assistant engineer, who directs all of the work from orders given him by the chief engineer. As he, of course, cannot be on watch more than the regular hours, unless in case of emergency, the orders are transmitted by him to the watch engineers, and in absence of the chief engineer these men have, in their consecutive order, absolute control over every piece of steam apparatus and the appurtenances thereto, from the ends of the crank shafts to the outer end of the circulating water intake, including all labor incident to steam operation.

The first assistant and his watch engineers are busy men. I say "busy," because, if they are not, they are in the wrong place, for on these men we place secondarily the responsibility of the steam apparatus and its operation. The first assistant is especially held responsible for economy of operation, both in labor and material, of the steam system. He must notice and report to his chief any repairs needed, whether large or small, whether it be the keying of cranks or wrists, opening of cylinders, adjustment of pistons, packing leaky valves or glands, leaky steam lines, whether they be main or drips; must look after the water lines; the proper working of the air and circulating pumps; the condensers and canals; the undue consumption of cylinder or engine oil and waste; the oil system, and also, incidentally (although he has a watch engineer in charge under him), must notice and criticise the number of boilers in line to operate the number of engines in service when using certain grades of fuel; in fact, it is required that he be a man who can think quickly and not take too much time to execute. He must be thoroughly conversant with every line of

steam and water pipe, every valve and its use, and what will probably occur if misused. It is his duty to instruct all the men under his charge in the working of every piece of apparatus in the steam system, and if he is found to have inclination to dispense only such information as is absolutely necessary for his men to operate with, with an idea that he knows the system as no other man does, and he thereby hopes to insure his position more permanently, he is not the man for the place, because he is working for his own interest specially and incidentally only for that of the company. On the other hand, he should make especial efforts to have every man under him thoroughly conversant with the system; first, because it is for the best interests of his employers; secondly, because in a way it will lighten his own labors; thirdly, he will receive the credit due from his men, and those men will appreciate his efforts to place them aright in their work; and, last of all, his chief will appreciate the fact that he knows how to work his men and produce results that the company is looking for, and this without discontent in the ranks.

Again, there are cases of emergency when the first assistant is required to work overtime, and so must his watch engineers as well, and their men, and here the treatment of the men should be thought of. If they are working by the hour and are allowed overtime they will probably be satisfied; if they are working by the week and don't get overtime but do get a number of days off with salary each year, they may feel that they are losing something by reason of such emergency. In such an emergency my instructions are to see that the men are well fed and that they are given such reasonable time to recuperate as the load demands on the system will admit, and I may say that with this latter method we have no difficulty.

Watch Engineers.—Of the watch engineers we must require as nearly as possible the duties of the first assistant, with the addition that the orders of the latter, as to work to be done during the hours he is absent, are to be strictly obeyed, and the results must show favorably when he again appears on watch. It is in these cases particularly that good discipline among heads of divisions shows itself prominently, and if it does not exist, the repairs on apparatus will fall behind, and, little by little, we shall begin to find the system in a bad position and one from which it means hard work and long hours to get back into line.

The Oilers.—The oilers come next in line in the engine-room, and on these men we rely to keep the engines in operation after once started and to know absolutely that the large number of oil feeders and grease cups found to-day on reciprocating engines are in proper operation. An oiler must give immediate notice to the watch engineer of any irregularity in the operation of his machine; must see that he is using enough oil, and not more than enough, and when his machine goes off the line must wipe it up and clean it ready for the next run. These men are important in their positions, whether the title implies it or not, for power stations, unlike steamboats, cannot afford to shut down to cool hot bearings, nor can we afford to let the customers drift, as the commander might let the ship drift at sea if emergency occurred and weather and sea room were favorable.

I consider an oiler important when the question of hiring men comes up in the fall. I lose no opportunity to take the name and address of all men who have had experience in that line, and find such a list very useful when the fall load begins to appear.

We should, and on our system we do, pay oilers who can oil an engine properly one rate of wages, and that only to such men as are competent to run the pumps when required; and with beginners on the system we practice the method of moving them along and higher in the matter of wages as they grow more proficient in the work, and lose no proper opportunity to show them that proficiency is the one thing most needed, and that such an acquirement, together with a strict observance of orders from their watch engineers, will lead them to acquire the maximum wages paid for that line of labor.

The cleaners come last in the line of engine-room labor, for in the matter of repairs, the first assistant and such oilers as are at his command take care of such repairs as can be properly done in the station, while such repairs as are heavy, or those that require machine work, are done by contract by outside parties, our experience being that this is the least expensive method.

The cleaners should be in evidence in every well-regulated power-house, for the reason that in these days of modern buildings and machinery nothing detracts from the appearance of an engine-room more than filth. In my opinion, when we consider the vast number of customers we serve and the prospective customers who visit our power houses by virtue of passes given them from our general offices, we can afford to keep our stations clean and add to our reputation in worth more than the cost amounts to, and I think any conservative central-station man will agree with me. More than this, the cleaner is a general utility man; he is useful at a great many times when another man or two must be had, and in case of emergency we can, under the eye of the watch engineer, have him oil an engine or do other work properly in his line.

The Boiler Room.—We can now take up the operation of the boiler-room, that portion of the system which can be so handled as to assist greatly in paying dividends, and can also be handled in such a manner as to be largely the means of passing one, especially if the coal supply is uncertain as to quantity and quality, for in this latter case we must necessarily save at every other point in order partially to make good such deficiency. Therefore let us at once have the fire-room in charge of a competent man whose immediate superior is the engineer on watch. We need a man for this place who carries a first-class engineer's license; one who has had experience in the engine-room and thus understands practically how the load rises and falls; one who will keep in touch with the watch engineer and realize that it is absolutely necessary that he does keep in touch with that man and knows as far ahead of time as is possible what his future needs will be.

We need in this man ability to supervise repairs of all kinds in the boiler-room, including boilers, pumps, headers, leads, valves, furnace brickwork, grates, and all other items in that part of the system. We want him also to be a man of sterling worth in the handling and judging of men, and we want him to realize that a fireman is a man and, as such, is entitled to proper treatment at all times. We want him to have ability to judge whether or not a little encouragement will bring out the best efforts of the man, or whether it is necessary in order to obtain such efforts to place the man strictly on the line and make him understand what results he must obtain if he stays on the pay-roll. We want him to be obedient to his superior

and be able when he goes off watch to have his work laid out to cover the time until he again appears; such a man as I describe should receive the same salary as a watch engineer, not because he ranks as high in the line, but because he can earn the money.

The Water Tenders.—Next come the water tenders, who are in charge of the fire-room watches when the foreman is off watch and who, in such periods, are immediately responsible to the watch engineers, and have a quota of firemen under their charge, as well as all other men of the fire-room force. The water tender may be apparently perfectly competent to occupy his position by reason of his coming to you with a proper license and a long list of recommendations from former employers, but the question will arise as to whether he will fill his proposed position as follows: Will he pay strict attention to the instructions given him by the foreman of the fire-room, or the watch engineer, if that man be in charge, as to the probable demand for steam; does he watch his boiler feed and regulate his boiler feed-water apparatus so that with a heavy demand he is not caught with water too low, and then when absolutely obliged put in water in larger quantities than usual, causing his firemen to do some very heavy work and probably some uneconomical firing, a few repetitions of which will cause complaint and discontent among his men? And, from the other point, does he pay attention to the decreasing load and work the water up to the proper point, and go along the line and watch the depth of the fires, and instruct his men, as per his instructions from the watch engineer, that the load is "going," and to avail themselves of the opportunity to clean fires, to fire light, or bank, or both? Does he watch the steam leaks within the limits of his portion of the boiler-room, and does he see the small repairs needed and report them to the engineer of the watch, even though he feels sure that the engineer knows of those matters? And, finally, has he the interests of the company in view? If he does not properly deal with these items he is not the kind of water tender we want, no matter what his ability actually is. It is extremely important that the watch engineer take particular notice of the water tender, not only as to his ability to perform his proper duties, but also as to his inclinations, and report to his superior if the man is delinquent in any way.

The Firemen.—The firemen are those of the force whom we must select with care, for the type we need must have had experience, and must have judgment and be reliable. That is to say, we can not afford to have a man with us who is afflicted with pay-day sickness. We want him eight hours a day seven days a week, and I am glad to say we have a large number of this kind who like their positions well enough to work steadily for the periods mentioned above. We want men who will obey the instructions given them by their superiors, and those who are free from connection with any organization that would interfere with men that are getting satisfactory wages and treatment and are contented. We want men who, when occasion requires, will hand-fire 2000 pounds of coal an hour, and do so for several hours, if necessary. We want men who will burn coal, and not simply dispose of it; men who will use judgment in both firing and cleaning fires, and if the plant is using stokers of the type we use on our system, it is of the greatest importance that he should watch the coal as it comes to him and regulate the depth of the feed and speed of the grate in accordance with both the quality of the fuel and the demand for steam as his best judgment dictates, and act promptly on instructions given.

As to the treatment of the men as a whole, I have learned by experience that a small amount of favoritism made apparent in the fire-room can and will cause discontent and a tendency to avoid the regular amount of work due to be performed by each man, because an idea is harbored to the effect that the other fellow is having an easier time; as, for instance, a water tender may so conduct his watch as to make the following watch clean fires when his watch should have done it, which entails on the men following a larger amount of work than they should perform, and also causes the latter to use an amount of coal not in proper comparison with the load on the system during the time they are handling the fires. Such matters should result in a hasty but nevertheless thorough investigation, the facts should be gotten at, and those guilty of such practice should receive positive assurance of what would happen if a repetition should occur.

The Coal Passers.—Last among the men classed as boiler-room help come the coal passers. On these men we depend not only for handling coal but for cleanliness of the room, and although it is a hard place to keep clean, it can be done to a degree that is eminently satisfactory to all who enter it. A little spare time on each watch, especially on Sundays and holidays, when the load is below normal, can be used in a manner not to cause reflection as to expense and, at the same time, make even the men who work in the room feel a sense of content, while a like feeling could not obtain in a fire-room which contained the dirt and filth of months of accumulation, with no prospect of its ever becoming better.

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Can a Steam Turbine be Started in an Emergency Quicker than a Reciprocating Engine of the Same Power?

A paper with the above title was read at the June meeting of the American Society of Mechanical Engineers by A. S. Mann and represents one phase of the "Steam Turbine Problem" which may not be of much importance in most plants but which in some instances may become the controlling factor in the selection of the prime mover. The paper is as follows:

If a large steam turbine is cold and at rest, how quickly can it be started? Can it be brought up to speed as readily as can a good cross-compound engine that is cold all over? Most station men would have doubts as to the adaptability of the large turbine, say 1500 kilowatts, or 2250 horse power, for emergency work. So much has been written about the sensitiveness of a rotating disc to the changes of temperature and the effects of unequal expansion that it is easy to imagine difficulties in the rapid start. The possibilities of an engine with a 62-inch low-pressure cylinder in starting practically cold and coming up to synchronous speed are well understood. A station manager would criticise an engineeer who would open his throttle as fast as he dared without wrecking his piping system and let his machine jump into her work. One turn at a time on the throttle is about all that is considered safe, and even then a close watch is kept for groaning valves and cold back bonnets.

Every time the starting valve is moved to increase the steam flow, the engine is allowed to take its full increment of speed, due to that particular throttle position before the supply valve

is moved a second time. There are ten large oil cups, and frequently more, that must be opened and adjusted before the machine moves at all, besides whatever oiling is to be done about the air pumps and other auxiliary apparatus.

Most engineers would consider ten minutes as rather a fast start and fifteen minutes as a more usual starting period, including time taken for warming up; in fact, it may not be overstating the case to say that if it were known that an engine-driven plant were to be called upon in emergency for power and it were essential that the briefest possible time were to elapse between the call and the taking of the load, one or more engines would be kept in motion all the time, turning slowly and hot all over.

This question makes itself very prominent when the steam station is operated as an auxiliary to a large source of high-tension power, which is itself in the construction stage and has a large overload capacity of its own to carry, supplying all sorts of apparatus that use electric power, railway, lighting, and power circuits, simultaneously. At such a time all sorts of accidents will happen to the high-tension water-driven plant, most of them due to the necessarily temporary character of many of the electrical connections. It takes months before an intricate system of wiring can be thoroughly relied upon, for it takes months before the temporary work of construction can be replaced.

The station at present under consideration is equipped with three Curtis turbine-driven alternators, 40 cycle, 10,000 volts, each of 1500 kilowatts normal capacity. During the summer months the station is operated as an auxiliary to a water power plant, taking all sudden overloads. A signal has been arranged, a ¾-inch whistle, so that it can be blown instantly should the power fail. A blast of that whistle means cut in two turbines and bring the third up to speed. The load will be heavy, and all auxiliary apparatus must be in regular operation.

Each turbine has a surface condenser and there are three or four pumps to be started for each pair of turbines; one circulating pump, one pressure pump for the step bearings and one dry-air pump, all of which are motor driven. The exciter is driven by a steam engine and must be started also, for it supplies current to a portion of the auxiliary apparatus.

The boiler room has steam up at all times, supplying a system for manufacturing purposes other than power, and slow fires are kept in enough boilers to make steam needed for the normal load. Forced load means forced fires. The boilers have under-feed stokers, equipped with pressure blast, and will respond quickly to a 50 per cent. excess call for steam. The operating force for this is about equivalent to a force for an engine-driven plant. Engineers and oilers, however, are busy about the building on construction work, installing new apparatus and taking such work as their regular occupation, when the turbines are not running.

At the sound of the whistle the water-tender starts a blower on the extra row of boilers; all blast dampers are opened up and all stokers are allowed to feed at the maximum rate. Each fireman dumps his free ash and bars over his red fire. The man in charge of the coal and ash conveyor starts the pressure pump for step bearings. One of the turbine men starts the exciter which supplies current to the auxiliaries besides its field current; a second turbine man starts the circulating pump and then his turbine. The hot-well pump and the air-pump are started by the oiler. These movements take place simultaneously. The force is organized upon the lines that obtain in a fire station; each man has his specific duty, and after performing it looks to see that there is nothing more for him to do. Only a few seconds elapse between starting the first pump and starting the first turbine.

The turbine throttle is opened as fast as an 8-inch steam valve can be opened without endangering the steam piping system. It is not considered advisable to open the throttle valve as fast as a man's strength will permit, but if nothing unusual occurs in the pipe line, sentiment does not spare the turbine.

One electrician attends to the switchboard and telephone. As soon as the machine approaches speed, the synchronizing system is cut in and the main switches are got ready. One and one-half minutes will do all the work here outlined, including the considerable time taken in mustering the crew from various parts of the building.

Manipulating an engine regulator so that it shall be at a precise speed and at an exact phase relationship from some other machine, not more than 1-1500 part of a second removed from it, is no matter that can be hurried, and one minute is fast time on such work. But the whole thing, phasing-in and all, has been done in 2½ minutes, including full load on the turbine, which started from a standstill.

This performance has been gone through a great many times, and our record book shows that out of 43 such calls 10 starts were made in 2½ minutes, 18 in 3 minutes, and 15 in 3½ minutes. We have taken the time in a number of instances when all the auxiliaries have been in motion, and it only remained to start the turbine and phase it in on the line; the only valves to open on such cases are the throttle and one small oil valve. The two quickest starts have been made in 45 seconds and 70 seconds, respectively, including phasing-in. Others range between 1 minute 10 seconds and 1½ minutes. These two quickest starts were made on a turbine which had stood for 24 hours with the throttle valve shut tight, though there was a slight leakage past the seat. After the throttle valve is off its seat it is not more than 30 seconds before the turbine is up to speed. A cross-compound reciprocating engine of the four-valve type, 2250 horse power capacity, can be brought up to speed from a standstill in five minutes if it is hot all over. This five minutes is to be compared with the seventy seconds required for the similar turbine operation.

A reciprocating engine, which is turning over slowly with the throttle valve just off its seat or with by-pass open and having all its oil cups open and regulated, can be brought up to speed, say 75 turns, in 2½ minutes. This can be compared with the 30 seconds necessary for bringing the turbine up under the same conditions; that is, about one-fifth the time necessary for bringing up the engine.

If the engine is cold all over and has all its oil cups shut tight, all its auxiliaries quiet, 15 minutes is called a rapid start. Starts have been made under such conditions in 12 minutes. When we start a cold turbine we open up the valve and let her turn, and in two minutes we are ready to bring her up to speed and she will be at speed in 2½ minutes, dividing the engine's time by more than four.

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It has been suggested that the term horse power be changed to mule power when applied to automobile engines.

The
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PUBLISHED ON THE FIRST OF EACH MONTH BY

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The Tantalum Incandescent Lamp.

The recent discovery of the new metal, tantalum, has resulted in giving to the engineering world a lamp which bids fair to outrival the carbon incandescent lamp. Long ago, engineers had given up the idea of using a lamp with a metallic filament because all the metals known to science failed, when tested as a light-giving medium when heated to incandescence by the electric current. None of these metals compared at all favorably with the vegetable fibre, but the discovery of the tantalum filament has changed these views.

The tantalum filament has a low initial resistance and gives out a light which is very much whiter than the incandescent lamp; its light more nearly resembles the Nernst lamp or acetylene flame. Its low power consumption per candle power is the chief factor which will make it a worthy rival of the carbon incandescent lamp.

The tantalum lamps are now made with 22 candle power and consume only 44 watts, as compared with 50 watts for a 16 candle-power lamp; that is, while the carbon lamp uses about 3.5 watts per candle power, the tantalum lamp only uses 2 watts per candle power. The enormous saving in power that would result in the introduction of this lamp on commerical circuits is very evident. Not only would there be a saving of over 40 per cent. in the consumption of power at the lamps but the losses in the lines would be very much less with the lighter current supplying the same candle power.

While the lamps are still very new, tests have been made which indicate that their life is somewhere in the neighborhood of the life of a carbon lamp. One of its particular advantages over other lamps, which have been designed to replace the carbon incandescent lamp, is the fact that it can be used in the same socket where the ordinary lamp is now used; all other lamps usually requiring some special form of socket or other requirement.

If the tantalum lamp proves to be an efficient, durable and economical lamp, it would seem at first thought that many power houses selling electric current for incandescent lighting would have their revenue cut almost in half by the introduction of this new lamp. This would probably be true if all the lamps on the circuit were changed at once, but, if the past is any index to the future, the more light the consumer has the more is wanted, and besides it would increase the demand for light from a great many small consumers who are not now using electricity for lighting purposes.

It should also be the means of saving a considerable amount of coal in an isolated plant. If the cost and life of the tantalum lamp approach anywhere near the carbon lamp, it would be in these plants where they would, most likely, be first installed to any great extent.

Since it is for the purpose of saving every drop of energy that an engineer works so hard to maintain a high efficiency of his plant, any piece of apparatus that utilizes this energy more efficiently should be welcomed heartily.

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Motor-Driven Refrigerating Machines.

The electric motor reminds one of the little Jap, because it adapts everything to its own use and applies the brains which are used in designing machinery, so that it can be the motive power. One of the latest applications of the electric drive is in the refrigerating field, where there has been a demand for compressors to be used where they can draw their power from central electrical power companies' mains or where steam or other power is not available.

In many plants, such as in office buildings, restaurants, meat markets, and confectioners' plants, the cost of large quantities of ice becomes quite an item, so that private schemes of refrigeration have been resorted to. It has been to fill this demand that motor-driven refrigerating machines are coming into use.

In discussing the unexploited fields for the use of electric power, Mr. T. C. Martin recently drew the attention of the National Electric Light Association to the advantages to the central station of acquiring a refrigerating power load, and he stated that wherever power can be furnished for less than 5 cents per kilowatt hour, automatic refrigeration by means of

apparatus now available effects a large saving over the cost of ice, even if the manifest advantages of cleanliness and convenience of operation be not considered.

One of the best-known installations, where the motor-driven refrigerating machine is used, is that of the Butterick Building, New York City, where cold water is supplied to over 1800 people located on the 18 different floors of the building. An economy test on this plant is said to have shown the cost of electricity per ton of refrigeration to be 55 cents.

Economical Engine and Dynamo Loads.

With a given engine and dynamo, which are directly connected, the question is often asked as to which will be the most economical load to run the unit. This depends to a large extent upon the nature of the load and the relative size of the engine and dynamo, with which the operating engineer has little to do. The best he can usually do with a given plant is to regulate the number of engines to take care of the load.

When installing a dynamo and engine, it is often customary to take the rated power of the engine and choose a generator with a capacity as close as possible to it; that is, the number of kilowatts output required is found by dividing the rated horse power of the engine by three-fourths. This may sometimes be the very best practice but in many other cases it may not be.

Engines are, as a rule, rated at the power which they generate when cut-off takes place at the most economical part of the stroke, this being usually in simple engines about one-fourth the stroke. Under these conditions, the engines are capable of working at heavy over-loads, by simply lengthening the time of admission of the steam, without any injury whatever, the principal objection being the increased steam consumption per horse power due to the decreased expansion of the steam.

Dynamos are, however, rated at the output which they will give continuously without overheating. Whether this maximum allowable load is the most economical one or not depends upon the design of machine. It may be that a smaller load than the maximum will give the most economical results or it may be that a heavy overload will show the greatest efficiency.

The selection of the proper size engine and dynamo depends upon the nature of the load and the efficiency of the unit. For instance, with units carrying highly fluctuating loads, such as for small isolated plants with elevator loads or with small railway plants, it is usually customary to run the units considerably below that at which they are rated in order that the fluctuation will not cause the load to run up much in excess of the rated load. With the most modern machines this is not so important, due to their better construction, but with a fluctuating load it is usually better to have a smaller size engine than dynamo and allow the engine to run at its most efficient point of cut-off, overloading it when necessary, than to have a large engine and small generator. Some plants are installed which use a large engine with a small generator but it is probable that its chief advantage with varying loads is the increased fly-wheel capacity of the larger engine, which generally means closer regulation.

Where there is a steady lighting load or where the use of a number of units can be varied to suit the output, the dynamo and engine should both give the maximum efficiency at their normal load, and the load on the unit should be regulated, if possible, so that the load should be maintained at that amount.

Steam Consumption and Efficiency.

The question of efficiency pertaining to a reciprocating engine or a steam turbine is generally gauged by the amount of steam consumption which each machine uses per horse power developed. If the conditions of steam pressure, superheat, and vacuum remained the same in every case, this would be true, but if the steam consumption is given without reference to any of these important things, it may be that the machine which shows the largest steam consumption will have also the largest efficiency, and the machine which runs with a small steam consumption will not be as efficient as the figures indicate.

The steam consumption represents the relative efficiency to the owner of the plant, while the efficiency of the prime mover depends upon the output of the machine compared with the maximum amount of energy available between the conditions under which the steam is received by and discharged from the engine.

Cooling Compound for Hot Bearings.

The following is said to be a good cooling compound for hot bearings: To a good quality of white lead add double the quantity of tallow; mix with this a little cylinder oil to make it run, and feed to the hot bearing. It is said to work promptly and efficaciously.

The vacuum in a surface condenser may be wholly or partly lost by a leak in the condenser, a leaking stuffing box on the low pressure cylinder, a leaky air pump, not enough circulating water, circulating water too warm, circulating pump being out of order, leaky pistons, leaky valves in cylinder. In a jet condenser, the vacuum will be lessened by having too warm injection water or too much of it, not enough injection water or the spray may be clogged.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

The Mysterious Explosion.

EDITOR THE PRACTICAL ENGINEER:

The subject of boiler explosions is one always full of interest to engineers, to owners of steam plants and to insurance companies, not to mention the general public. And considering the fact that in the great majority of cases the accidents are enveloped in a veil of mystery which prevents the exact causes from becoming known, any authentic circumstance which bears directly upon the causes of inexplicable explosions is welcomed by all concerned.

In the first place, if the man in charge at the time of an explosion is not killed, and knows the cause of the catastrophe, he will not divulge it, as in almost every case it would disclose some gross carelessness on his part. In cases of badly eaten shells where the cause of rupture is apparent, the blame cannot fall on the engineer in charge; but there are cases of general carelessness which might be disclosed and the mystery cleared up if the water connections could be found and examined. It is just such a case as this last that I wish to present to the readers of "The Practical Engineer," and the reason the causes leading up to it are known to be authentic is because, as an Irishman might say, the explosion did not occur at all! And paradoxical as it may appear, the very circumstances which made it extremely probable, operated to prevent its consummation.

The situation, briefly stated, was something like this: A planing mill having a battery of two horizontal return tubular boilers, was using but one at a time during the summer months, and would change off every week to clean out. As steam had to be kept on the dry kiln all the time, the Sunday watch had to fire up the cold boiler to about 30 pounds and keep it there until relieved by the night watch. On the Sunday evening in question, the watch had filled the boiler from the city main which had a pressure of about 120 pounds, and then started his fire. Before steam began to rise he noticed that the boiler was too full and went and opened the blow-off until the glass showed the proper water level; then according to his story, he closed the blow-off and putting in a good fire, made his regular rounds of the plant, which is a large one, and requires the best part of a half-hour to inspect. When he returned to the boiler room, the glass showed no water, and as the watch was a young man of practically no experience, he immediately turned on the city water without even trying his gauge cock, expecting that in a few minutes the water would show in the glass. Instead of pulling his fire, he put on more fuel and waited for the water to come up; but the night watch came in before the water appeared and immediately inquired where the water was. "Oh, it'll be here in a minute," said the young man, but after the night man had changed his clothes and still no water, he tried the gauge cock and still no water appeared. Then he pulled the fire, and when the boiler could be examined, it was found that the water was below the flues. The boiler had been so hot that it leaked all along the seams and at the ends of the flues, and there was no apparent reason for its not exploding, although the battery was a new one with a working capacity of 250 pounds.

An examination of the water connections developed the facts that the feed water pipe had become partially obstructed, and at the same time a piece of scale had lodged in the blow-off valve so that it was left partly open. Now we may see the results of this queer combination. The water kept running out of the boiler slightly faster than it was coming in, constantly reducing the contact surface, which in itself would hold the pressure within a safe limit. The feed water pipe entered the front of the boiler, passed to the rear and discharged half way down the side of the shell, or approximately close to the blow-off outlet, so that the cold water which was slowly coming in, being heavier than the main body, simply ran out through the open blow-off without coming into contact with either the shell or the flues.

It makes one shudder to think what a ticklish situation unconsciously confronted the men in charge, the plant and the whole neighborhood. Had the escaping water carried enough scale into the blow-off pipe to check the flow, the inevitable would have happened, as also would it, had the obstruction in the feed water pipe suddenly given way.

Now, had this explosion really occurred, its cause would, in all probability, never have been known; and when surviving engineers tell stories of safe water levels and low gauge pressures, let us give them the benefit of the doubt, for a case like that above might develop in a very short time, and the breaking loose of the water while the engineer was in the engine room would blow things sky high when he was resting in the greatest security.

It is not my purpose to prescribe the preventative for such accidents, for it will appear to every engineer, but it is a plea for the veracity of the man in charge who says that the apparent condition of the plant was correct and that the cause of the explosion is a mystery.

CHARLES CLOUKEY.

Cause and Remedy of Some Leaks in Boilers.

EDITOR THE PRACTICAL ENGINEER:

Many different engineers operating steam plants have different ideas of furnace and combustion chamber arrangement. The accompanying sketch, Fig. 1, shows one of these the writer came into contact with recently when called upon to oversee some overhauling and repairs to two tubular boilers.

It seems that the plant had been shut down for some time and steam had been kept up on one boiler to prevent the pipes from freezing. The man in charge upon being questioned what was at fault said that the boilers were leaking badly at the blow-off pipe flange at B. It was also leaking at the threaded part at C and the rivets and seam at the back head A also leaked and showed signs of fire cracks.

When I attempted to examine the combustion chamber, I

found it filled with ashes to a height shown by the irregular line D. The ashes had evidently not been removed often enough and their accumulation directly around the elbow at E had protected it, for it showed no signs of leaking, but it caused the rivets in the blow-off pipe and the rear girth seam to leak by reducing the space allowed for the flame to pass and thus raised the temperature higher than it should be.

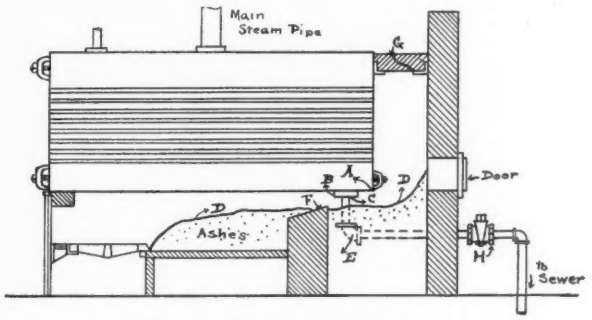


Fig. 1.—Cause of Leaky Boiler

After the combustion chamber was cleaned out, I was surprised to find the bridge wall as shown at F, its highest portion being but 8 inches from the bottom of the shell. Fig. 2 shows how the bridge wall was rearranged. The blow-off cock at H, Fig. 1, was also leaking and I suggested taking it off and it was replaced with an angle blow-off valve, shown at I, Fig. 2. The old asbestos packed cock at H was taken out entirely and a new piece of pipe put in from elbow at E, to flange of angle valve at *m*. A new flange was put in at B, new pipe at C and seams and rivets of girth seam well caulked. The angle blow-off valve proved the handiest valve on the boiler for it could be taken apart at *m* in a very few minutes to allow for examination of the piping or the disc of the valve. Many times since that valve was put on, by disconnecting the flanges, a rod was inserted in the blow-off pipe which got rid of any piece of scale that had become lodged there.

The man in charge also complained that the draft was very poor and upon examination of the rear arch, we found it

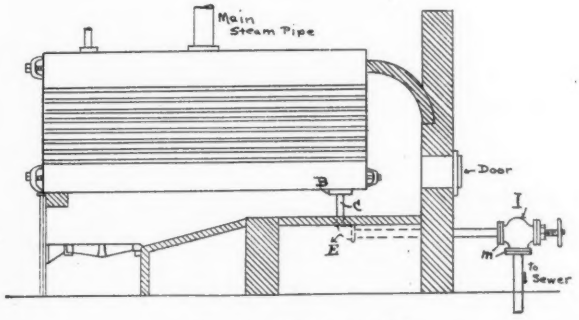


Fig. 2.—Remedy Applied

cracked, as shown at G, Fig. 1. The bricklayer repaired the arch, as shown in Fig. 2, which prevented its cracking.

The man in charge was cautioned about letting so much ashes accumulate in the combustion chamber and after a two days' run, they reported to the writer that everything was O. K. and it has been ever since.

Depew, N. Y. W. Micro.

Rules for Boiler Bracing.

Editor The Practical Engineer:

In looking over "The Practical Engineer" for May, I believe it to be the best engineering paper published. I see in that issue where F. L. K., of Stillwater, Minn., wished to have boiler bracing explained to him. The rules you gave him were good, but I believe it would be better satisfaction to him if a problem was worked out. I will therefore work out a problem according to the specifications of the American Boiler Manufacturers' Association.

Let t = thickness of plates in sixteenths of an inch.
P = steam pressure in pounds per square inch.
A = area supported by one stay in square inches.
l = length of centre line of diagonal stay measured between head and shell.
b = distance from intersection of centre line of diagonal stay with shell to the inside of the boiler-head measured parallel to the shell in inches.
L = load on one stay.
S = load per square inch of section of the stay.
d = diameter of stay.
p = pitch of stays in inches.
N = number of stays required.
a = area of stay in square inches.

To find the maximum permissible distance between stays for plates up to $^7/_{16}$" thick use 112 as a constant, for plates above $^7/_{16}$-inch thick use 120 as a constant, and with screw stay bolts with nuts inside and out use 140 as a constant.

Now, suppose we wish to find how many stays, their diameter and their pitch, necessary to support one end of a boiler, the area to be braced being 720 square inches and the pressure 100 pounds per square inch, the plate being $^7/_{16}$-inch thick. We will assume a load of 6000 pounds per square inch of section of the braces.

Then $A = \frac{112 \times t^2}{P} = \frac{112 \times 49}{100} = 54.88$ square inches that may be supported by one brace without the plate bulging between the stays. The pitch is the square root of that number, or, $P = \sqrt{54.88} = 7.4$".

The number of stays required is $N = \frac{a}{A} = \frac{720}{54.88} = 13+$, or, say, 14 stays.

The diameter of the stays is

$$d = \sqrt{\frac{A \times P}{S \times .7854}} = \sqrt{\frac{54.88 \times 100}{6000 \times .7854}} = 1.079$$

or, say, 1⅛ inches.

If the stays make an angle with the surface they support, the load on the stay will be increased and the diameter and area of the stay should be calculated, as the different stays make different angles with the surface. The formula for finding the diameter of a diagonal stay is

$$d = \sqrt{\frac{1 \times A \times P}{b \times S \times .7854}}$$

Saginaw, Mich. E. E. H.

A Troublesome Pump.

EDITOR THE PRACTICAL ENGINEER:

I have picked up several good tips from the letters written by different engineers where they describe their troubles and how they overcome them, so I am going to tell them some of my late worries.

A double-acting pump was recently delivered to the engineering department where I am chief engineer, the two outside packed plungers of which were built tandem with a water-tight wall between them. As we do all our own pipe work and repairs, I had one of the fitters connect it up. When all was ready, the steam was turned on but it passed right through the chest and out of the exhaust pipe without moving the piston. Upon examination it was found that the rubber gasket which was between the steam chest cover and the cylinder extended inside far enough to hold the valve off the seat. We attended to that and tried again and it started off fine.

We allowed it to pump a few minutes through an open pipe and then turned it into a boiler which was in operation, but instead of the water level raising, it steadily lowered. The valves on the pump were examined and found O. K. The water ran to the pump by gravity and I was sure that all the other pipes were right. I removed the pet cock over the valve chamber, attached a steam gauge instead, and closed the valve on the discharge pipe and again started the pump.

There was 90 pounds steam pressure on the boiler but we could not get the pump to work up a pressure of over 50 pounds with the feed valve closed and the pump running ahead fine. I tell you I felt like attending the funeral of the maker of that particular pump. Well, after using up a lot of fancy expressions mingled with plenty of perspiration, a hole was discovered in the dividing wall and the pump had been simply pumping from one cylinder to the other. The pump was removed and another one installed. The firm who manufactured this pump is reputed to be reliable but the pump had certainly never been tested on the water end and very little if any on the steam end.

Toronto, Canada. JAMES E. NOBLE.

Quick Repair to Gas Engine Piston Ring. Loose Bed-Plate Caused Knock.

EDITOR THE PRACTICAL ENGINEER:

We had a quick rush job to get out in our factory some time ago and as is usually the case, a break in the gas engine occurred just at the most inconvenient time. A piston packing ring broke, and, as our engine was overloaded, making it necessary to have it in the best condition to do the work, we had to repair it at once. We had no extra rings and it would have taken some time to get one made and delivered to us. Had it not been a gas engine, it could probably have been packed with regular steam packing, but the ring had to be made of metal to stand the heat.

One of our men said he could repair it, so he took the broken ring and made an impression of it in some clay sand. He then melted some scrap zinc and poured it in the mould. The result was a shiny ring that required very little polishing to make it smooth. We used great care in springing this on the piston and when finished, the job was a good one and only required two hours' time. We ran with this ring until the end of the week, even though the other rings had been received.

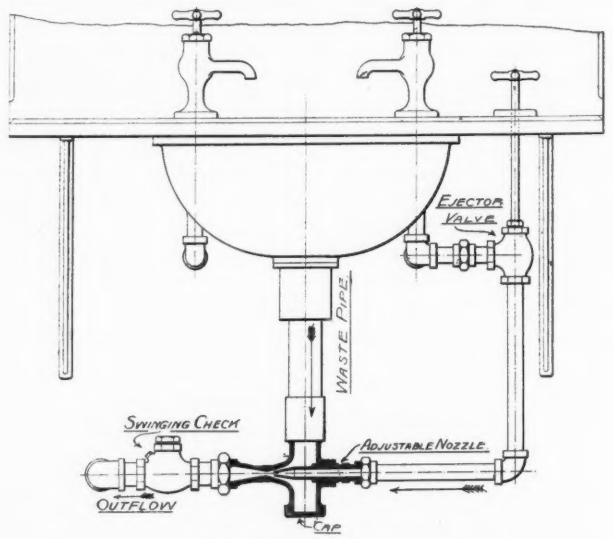
This same engine at one time had a pound that seemed to be located in different places. We had several experienced men to look at it but the knock could not be located. There was no lost motion in the bearings or fly wheel, the piston was a good fit and nothing could be found which was wrong. We were about to give up in despair when a little ridge of oil was noticed working at the edge of the engine bed at each impulse the engine received, showing that it was loose on its foundation. I had never heard of this causing a knock, but when tightened, the knock disappeared and was heard no more.

Lancaster, O. R. W.

A Simple Ejector for Waste Water.

EDITOR THE PRACTICAL ENGINEER:

Whenever a wash-stand or sink is below the level of the drain or sewer, the problem of disposing of the waste water is usually a troublesome one. The accompanying figure shows an arrangement for emptying a wash-basin by mean of an ejector placed directly underneath it. The ejector is operated by means of a valve conveniently located at the right of the wash-stand. It is a very simple brass casting, having a quarter-inch nozzle and a cap on its lower side, which can easily be unscrewed should it be necessary to clean out the drain pipe leading down from the basin. With the city water at a pressure of 40 pounds per square inch, an ordinary basin 12" x 16" and 7" deep can be emptied in less than 4 minutes, the outflow being against a head of 7 feet. A check valve is placed between the ejector and the outflow pipe to prevent the return of the water, and this check should be at least a foot from the ejector or it will interfere with its effective action. As few turns as possible should be put in the outflow pipe and 45° turns rather than ells should be used. The outflow pipe should be at least one inch inside diameter.



A Waste Water Ejector

This arrangement has been in constant use, during the past year, in the basement of the Drexel Institute, and it has given great satisfaction.

Phila., Pa. T. S.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Valve Trouble.

EDITOR THE PRACTICAL ENGINEER:

An engine which cuts off equal on both ends has a valve which moves faster at the crank end than on head end. Would it have any effect on the end it moves the fastest; that is, would there be a higher pressure at the crank end than at the head end? The valve gear is of the Wolf type and at the crank end it receives a quick opening but at the head end it opens about one-eighth inch and then comes to kind of a stop and stays there for a while and finally comes back, cutting off the steam at the same distance as at the crank. Would you increase the lead at the head end or would you let it go?

Wabasso, Minn. F. J.

If the valve was set so that cut-off took place at the same distance from each end, the principal effect of a slow moving valve would be to wire draw the steam at admission and give a decidedly rounded cut-off, instead of a full admission pressure and sharp cut-off, which should be aimed at. The effect of this would be in the above engine to give a higher mean effective pressure in the crank end than in the head end.

There are a number of ways by which this could be remedied, but all of them more or less depend upon a properly designed valve. Increasing the lead, as suggested, would give an earlier admission but it will give an earlier cut-off and it is probable that this would make matters worse.

It appears from the above description that the valve should have more travel; that is, the eccentricity should be increased. If the valve chest will permit it, the valve can be given more travel by increasing the size of the eccentric. This will then give the valve overtravel so that admission and cut-off would take place quickly.

Foaming in Boilers. Taking Charge of a Plant.

EDITOR THE PRACTICAL ENGINEER:

Will you oblige me by answering these questions:

(1). Can a boiler be tapped while under pressure?

(2). Can foaming in a boiler be stopped without shutting down?

(3). What is the proper thing for an engineer to do when taking charge of a plant when it is running?

Westboro, Ohio. P. T.

(1). No. A boiler should never be repaired when under pressure.

(2). Whether foaming can be stopped without shutting down depends upon the conditions of the boiler, the kind of feed water and the rate of evaporation. It is generally caused by a dirty condition of the interior of the boiler or the presence of oil in the feed water. A poorly designed boiler or one which is too small to perform the work required of it will also tend to cause foaming.

In order to stop it without shutting down, the water in the boiler should be changed as soon as possible, which can be done by putting on a strong feed and blowing out continuously or at short intervals. Care should be taken, however, before doing this, to be sure that the water level is not too low because the introduction of a large quantity of comparatively cool feed water might injure the boiler. If the engine could be stopped for a short time, the fire door of the boiler should be opened and the surface blow used, in which case if the foaming was due to impure feed water, the impurities which collected on the surface would be blown out. Whatever method is used, it will require the constant care of the attendant in charge until it is remedied.

(3). The proper thing for an engineer to do, when taking charge of a plant when it is running, is to keep it running. Find out from the preceding engineer in charge, or from those attendants that are left, the peculiarities of the plant as regards the load, kind of feed water, etc. With these things in mind, observe the operation of the plant, examine all the valves and machinery carefully and make a note of everything which should be repaired or changed. At the first opportunity, when the plant is shut down, examine the boilers, inside and out, be sure that the safety valve does not stick and the water column is free from scale. If there is much scale within the boiler, steps should be taken to secure a proper compound to prevent its formation. There are many other things which might be mentioned but the engineer on the ground will at once "feel it in his bones" that certain things must be repaired, replaced, or looked after.—[Ed.]

Engine Horse Power. Loose Brasses.

EDITOR THE PRACTICAL ENGINEER:

Will you please answer the following questions:

(1). What is the horse power of my engine? It is a 14 x 18, running 200 revolutions per minute, with 80 pounds boiler pressure.

(2). Will you tell me what to do with my crosshead? The brasses fit snug in the crosshead but the connecting rod can be slipped back and forth. As the brasses can't move, how can I keep the rod from moving?

Edinburg, Ind. W. G. A.

(1). The nominal horse power of the above engine assuming cut-off to take place at one-quarter stroke is 110 horse power.

(2). The lost motion can generally be taken up, when the brasses do not move, by the use of shims or liners.—[Ed.]

Alternating Current Transformer.

EDITOR THE PRACTICAL ENGINEER:

I have a 75 ampere 220 volt machine. Can I reduce the voltage to 110 by using a transformer? How is a transformer built for these conditions?

Cudahy, Wis. A. H.

If the current is alternating, it can be reduced from 220 to 110 by means of a transformer.

It would be impossible to give all the details in the design of a transformer in this short answer, but in general, it consists of an iron core made up of sheet iron laminations which are insulated from each other. The two coils of wire wound on the core are called the primary and secondary. In this case the primary should have twice as many turns of wire as the secondary; the wire in the primary being large enough to carry 75 amperes without heating and the wire in the secondary being large enough to carry 150 amperes.

In general, a transformer consists of an iron core and two coils of wires, the ratio of transformation depending upon the ratio of the number of turns in the primary and secondary coils.—[Ed.]

Speed of Ship for Different Speeds of Engine and Different Slips of Propeller.

EDITOR THE PRACTICAL ENGINEER:

Here is a question I would like to have you answer:

An engine turning 90 revolutions per minute with 24 per cent. slip runs a ship 10 miles an hour. How fast would the ship run if the engine was turning 100 revolutions with 26 per cent. slip?

Buffalo, N. Y. W. E. C.

To work out this problem in a logical manner, it would be best to first find the pitch of the propeller. Since the engine runs 90 revolutions per minute or 5400 revolutions per hour, and the boat travels 10 miles or 52,800 feet per hour, for every turn of the engine the boat travels $52{,}800 \div 5400 = 9.777$ feet. As the slip of the propeller is 24 per cent., this 9.777 feet only represents 76 per cent. of the pitch, so that the pitch equals $9.777 \div 0.76$ or 12.86 feet.

To find how fast the ship would run if the engines were turning 100 revolutions per minute, it is only necessary to multiply the revolutions per hour by the pitch and by the slip at the given speed and divide the result by 5280, the number of feet in one mile. In the above example, $6000 \times 12.86 \times .74 = 57{,}098$ feet per hour, which, divided by 5280, gives 10.8 miles per hour.—[Ed.]

Thermal Efficiency of Engine.

EDITOR THE PRACTICAL ENGINEER:

What would be the thermal efficiency in a simple engine using 30 pounds of steam per hour per horse power, the efficiency of the boiler being 70 per cent. and the total heat in a pound of coal being 12,000 heat units?

Chicago, Ill. J. E. S.

The thermal efficiency of the engine is the number of thermal units used by the engine per minute for each horse power, as compared with a perfect engine converting all the heat energy of the steam into work.

A perfect engine would require $33{,}000 \div 778 = 42.4$ thermal units per minute per indicated horse power.

The heat chargeable to the engine per pound of steam is the difference between the total heat in one pound of steam at the boiler pressure and that in one pound of the feed water entering the boiler. If the boiler pressure is 100 pounds, the total heat per pound of steam is 1185 heat units and if the temperature of the feed is 200, then $1185 - (200 - 32) = 1017$ heat units chargeable to the engine per hour per pound of feed water used. The amount used per minute is $1017 \div 60 = 16.95$, and since the engine used 30 pounds of steam $16.95 \times 30 = 508.5$ thermal units per minute.

The thermal efficiency of the engine is therefore, $42.4 \div 508.5 = 8.3$ per cent.—[Ed.]

A New Four-Valve Engine.

A new type of four-valve engine, in the design of which especial attention has been given to the matter of steam economy, is shown in the accompanying illustration, Fig. 1. Chief among the radical improvements which have been made is the placing of the admission and exhaust valves directly in the cylinder head, rather than at the top and bottom of the cylinder, as has heretofore been the custom. This construction results in a reduction of practically 4 per cent. in the clearance, and it will readily be seen that the saving of steam effected in this

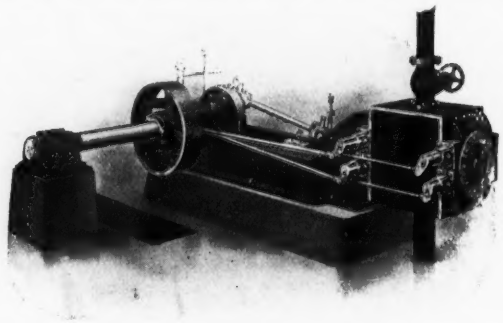


Fig. 1.—Atlas Four-Valve Engine

way is quite material. By this method, live steam is kept constantly in contact with the entire top of the cylinder and the upper portion of both heads, so that the loss of steam from cylinder condensation is greatly reduced.

The steam valves are operated directly from a movable eccentric forming a part of the automatic shaft governor, and entirely independent of the exhaust valves. The latter are operated from a fixed eccentric on the main shaft, in this way ensuring uniformity of compression under all conditions of load and pressure. The connections are all of the "straight line" type and involve no multiplicity of parts. The bell crank and toggle joint have been entirely done away with so that all lost motion is eliminated.

Both the steam and the exhaust valves are double-ported, and it is claimed that practically no "wire drawing" of steam exists in this type of engine, as shown in Fig. 2. Various tests made in the Atlas shops, as well as in the field, indicate a steam consumption practically identical with that of the Corliss type of engine, and a regulation of from 1 to 1½ per cent.

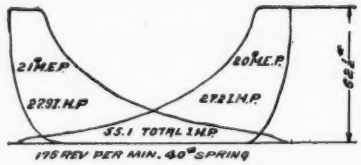


Fig. 2.—Indicator Diagram

under changes of load from friction to the full rated capacity.

In addition to the line of medium-speed engines, the builders, the Atlas Engine Works, Indianapolis, are also offering a high-speed centre-crank engine for electric service. This type has the reciprocating parts enclosed under an oil-tight hood.

At each revolution of the shaft the crank, crank-pin, crosshead-pin, crosshead guides and main bearings are showered with oil from a reservoir in the crank-pit, into which the connecting rod dips. Oil from the same source is also delivered by centrifugal force to all other reciprocating parts and is finally returned to the reservoir in the crank-pit. This system of lubrication has proven to be very effective, and coupled with the other advantageous features of the engine, should serve to make the latter very popular for direct connection to electrical generators.

The Jackson Belt Lacing Machine.

The accompanying illustration, Fig. 1, represents the Jackson Belt Lacing Machine, by means of which belt lacing has been reduced to a science. It was designed originally to save the cost of lacing but it is also especially valuable, owing to the speed at which a belt can be laced, in reducing to a minimum the loss caused by the stoppage of machinery due to broken belts.

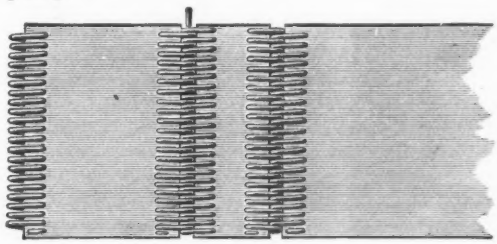
The belt lacing machine is relatively light and small and can be moved around by one man to the exact place where it is needed. It does not need to be fastened down and requires no power but the hand of the operator.

Jackson Belt Lacing Machine

The process of making a joint is as follows: Both ends of the belt to be joined are clamped in the machine and cut off perfectly square. After this, one end of the belt is clamped and by turning the handle, a little needle having the appearance of a piece of spiral spring is pushed through the leather in a spiral path, thus making the necessary holes in the belt. After it has made its movement through the leather, the needle is taken out and a piece of steel spiral thread is put in its place and given the same kind of motion the needle had before, thus bringing the end of the spiral wire through the consecutive holes which were made by the needle.

The spiral is now flattened in the leather, after which this end of the belt is completed. The other end of the belt is finished in the same manner, after which the two ends are pushed together, bringing the wires of the one end between those of the other end. The little rod is now pushed in place and the joint completed, as shown in Fig. 2. Each different thickness of belt has its own needle and its own size of spiral thread.

The advantages of this belt fastener are as follows: The belt remains the same thickness at the joint as the body of the belt, which is very desirable, especially in electric light installations; the fastener is very elastic and strong and is easily and cheaply made; there is no waste of belt material; it is easy to take the joint apart when the belt has to be shortened; it can be made at any place and can be used immediately; it can be used with tight and loose pulleys and the joint has sufficient elasticity crosswise to allow of its being used on crown pulleys.

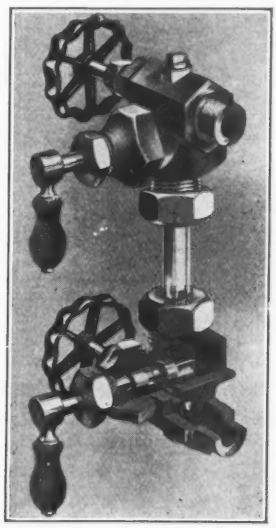


Jackson Belt Lace

The cost of lacing a 5-inch belt by this method is 1 cent and the cost of a 10-inch belt lace is 2 cents. These machines will lace belts all the way up to 24 inches wide and 5/8-inch thick. The Birdsboro Steel Foundry and Machine Co., of Birdsboro, Pa., are the manufacturers and they will be pleased to send references and other interesting data upon request.

Shallow Automatic Water Gauge.

To answer every requirement, a boiler water gauge should automatically shut off the escaping water and steam when the gauge glass breaks and at the same time it should be absolutely reliable and of such construction that failure to operate is impossible. It has been conceded that if a water gauge which



Shallow Automatic Water Gauge

answered all of these requirements could be devised, its use would have been, long before this, almost universal.

The Shallow gauge was designed with all of these objects in view, with the result that a gauge has been produced which is exceedingly simple in principle and operation. The instrument depends for its operation upon an automatic valve, a

clear idea of which can be had by examining the accompanying illustration.

The whole valve is constructed of brass, and the design of the passages and working parts is such that no trouble is ever experienced from the collecting of sediment or scale and the consequent sticking of the valve. The automatic valve is not subjected to wear except when it is closed through the breaking of a glass and as this occurs only at widely separated intervals, there can be no appreciable wear for many years.

The action of the Shallow gauge when a glass breaks is instantaneous, so that in practically every case some water still remains in the bottom of the broken glass after the valve closes. A new glass can be inserted at once without any preliminaries, except the closing of the hand valve, and as soon as it is in place, the automatic valves are brought into position for further service by simply turning the two automatic handles over once.

In connection with marine boilers in which very high steam pressures are carried, the use of an automatic gauge is of even more importance than in the case of stationary boilers, on account of the fire room space being very limited and the danger from flying glass, hot water, and steam being greater. The same thing is true on locomotives where engineers frequently throw the gauge glasses out of service and depend entirely on try-cocks to inform themselves of the height of the water in the boiler, the excuse being that the danger from a broken glass is greater than anything else around the locomotive. The use of an automatic valve as shown, would overcome these objections.

For further information pertaining to this interesting device, address William S. Haines Company, 120 South Fourth Street, Philadelphia.

Delegates at the Penna. State Convention of the N. A. S. E. held at Washington, Pa.

Seventh Annual Convention of the N. A. S. E. Penna. State Association.

The Seventh Annual Convention of the Pennsylvania Association of the N. A. S. E. was held at Washington, Pa., on June 2nd and 3d, in the public meeting room of the City Hall.

The Convention was called to order at 10 A. M., Friday, June 2nd, by State President, Chas. W. Snyder. After the usual parliamentary proceedings, President Snyder made his annual address, in which he set forth in detail the business accomplished by his office and called the attention of the delegates to the good work done by the license law committee, through whose efforts an act was recently passed by which cities of the 2nd and 3d class in Pennsylvania were given an engineers' license law.

The evening session was attended by quite a number of employers and friends of the engineers present, who followed the proceedings with a great deal of interest. The report of the license law committee was read by Mr. John C. Wollin, chairman of that committee, and it was received with applause by the delegates and their friends.

On Saturday morning, June 3d, the election of officers took place with the following results: President, John C. Wollin, Williamsport, No. 8; Vice-President, J. G. Lewis, Sharon, No. 6; Secretary, A. M. Munzinger, Williamsport, No. 8; Treasurer, Enoch Carless, Tacony, No. 9; Conductor, P. M. Hughes, Altoona, No. 23; Doorkeeper, L. P. Clark, Quaker City, No. 1.

A pleasing feature of the Convention was the attendance of the N. A. S. E. members from Pittsburg, who came in a large body from that city. Another commendable feature was the donation, by President Snyder, Secretary Pape, and Treasurer

Munzinger, of over one hundred dollars, which was the expenses of their offices during the year.

A resolution of thanks to the American Order of Steam Engineers was passed for the moral and financial support they gave to the license law committee of the State associations. This resolution was presented to the A. O. S. E. at their convention held in Philadelphia, June 12th to 15th; the committee on presentation consisting of C. W. Snyder, Jas. S. Gillespie, Jas. Rostron, John Buggy, and Richard Pape.

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NINETEENTH CONVENTION OF THE AMERICAN ORDER OF STEAM ENGINEERS

Philadelphia has always been looked upon as the home of the American Order of Steam Engineers. It is here that the Order is strongest in point of membership, and it is from this city that its policy has usually been directed. Therefore, it was to be expected that its Nineteenth Annual Convention, held in this city on June 12th, 13th, 14th, and 15th, would be a success; but even its most enthusiastic supporters did not anticipate the large assemblage; the large number of engineers, members and friends of the Order who gathered to celebrate the occasion.

In point of attendance it was decidedly the largest Convention ever held by the Order, while the interest manifested in the excellent exhibition of machinery and engineers' supplies, which was held in connection with the Convention, exceeded that of any previous affair of the kind at which it has been our good fortune to be present.

There were over forty delegates and officers in attendance, representing nineteen subordinate councils, and upwards of one thousand visitors. Most of the visitors were local engineers employed during the day but who were present in the evenings, when the various exhibitors were kept exceedingly busy explaining the merits of their products and entertaining old friends. Many of the exhibitors gave out interesting souvenirs of the occasion and these were industriously sought after, the demand for them being so great that the supply was soon exhausted and the late comers were deluged with cigars, of which there seemed to be millions.

The Convention was held in Harmonie Hall, 525 North Eleventh Street, the second floor of which was used for the business sessions, while the exhibition of supplies was on the first floor, with a large side room for refreshments. The business sessions began on Monday, the 12th, at 10.30 A. M., and were continued daily until 3.30 P. M., on Thursday, the 15th.

On Tuesday afternoon, a big steamer was chartered by the entertainment committee and everybody went for a delightful sail on the Delaware River. There were about three hundred aboard and all had a good time. The steamer went up the river as far as the famous Cramp's shipyards and then down the river as far as Chester, a distance of fourteen miles. The committee had provided ample refreshments for the occasion and the crowd was a jolly one. Some colored banjo players, provided by E. F. Houghton & Co., furnished entertaining music and on the return trip Jack Armour kept the crowd convulsed with songs and good stories.

At Wednesday's session the new officers were elected, resulting as follows: Supreme Chief Engineer, Hiram Trout, Reading, Pa., re-elected; First Assistant Supreme Chief, A. L. Dietrich, Baltimore, Md.; Supreme Recording Engineer, Chas. W. Leng, Philadelphia, re-elected; Supreme Corresponding Engineer, Frederick A. Markoe, Philadelphia; Supreme Treasurer, Geo. W. Richardson, Philadelphia, re-elected for the tenth time; Supreme Senior Master Mechanic, Joseph T. Harris, Milwaukee, Wis.; Supreme Junior Master Mechanic, Harry R. Taliaferro, Camden, N. J.; Supreme Chaplain, J. F. Hemphill, Wilmington, Del.; Supreme Inside Sentinel, W. J. Courtney, Columbia, Pa.; Supreme Outside Sentinel, H. L. Shirey, Stowe, Pa.; Trustee, W. S. Price, Atlantic City; Hold-over Trustees: J. C. McDowell and E. H. Naylor.

Harry R. Myers. The Popular Secretary of the A. O. S. E. Convention Committee

On Wednesday afternoon, the High Pressure Pumping Station at Race Street Wharf was visited. Mr. John Weaver, superintendent of the plant and honorary member of Municipal Council, welcomed everybody and gave an extended lecture upon the advantages and reasons for erecting a station of its kind for fire purposes. The equipment consists of nine gas engines, seven of which are of 300 horse power capacity. Since the primary object of the plant is to get started quickly, a demonstration of the ability to get the engines started was given, and in the short space of one minute, the engines were started from rest and ready to pump 1200 gallons per minute into the pipe lines at a pressure of 300 pounds per square inch. Compressed air, which is always kept stored in tanks, was used

for starting and since the engines are of the four-cycle, three-cylinder type, their cranks are always in an effective position to start at once. All the visitors were pleased to have seen this unique and well-kept plant.

On Wednesday evening a grand banquet was given in the main Convention Hall, at which over five hundred men were present. When the menu was exhausted the curtain at the end of the big hall went up and Supreme Chief Trout was introduced. In a speech all too brief, Mr. Trout thanked those present for the hospitality extended to the delegates and then retired from the stage amid a tumult of applause. The next speaker was Mr. John M. Lukens, Chief of the Bureau of Boiler Inspection for Philadelphia. Mr. Lukens spoke briefly of his efforts to increase the efficiency of the Bureau and referred with just pride to the excellent record made by the Bureau during the past two years. Mr. Lukens was also loudly applauded as he retired and the stage was then given over to a vaudeville troup who entertained the boys until a late hour.

Thursday, the last day of the Convention, was devoted to winding up details and to deciding where the next Convention would be held. Joe Harris finally won out and it was decided that the next Convention will be held in Milwaukee, Wis., during the second week of June, 1906.

Delegates and Visitors to the Nineteenth Annual Convention of the American Order of Steam Engineers held in Philadelphia

THE EXHIBITS.

H. B. Underwood & Co., of 1025 Hamilton St., Philadelphia, occupied the first space at the entrance to the exhibition hall. Their exhibit included specimens of broken engine parts, showing intricate and difficult repairs made by them in record time. Another interesting feature of their exhibit was the Kitchin Disengaging Hook. The exhibit was in charge of their popular Superintendent, Mr. Ed. Rooksby, who gave out souvenirs, key rings, and an interesting little booklet containing many points of interest to engineers.

John R. Livezey, 1936 Sansom St., Phila., had the next exhibit. It was one of the best equipped booths in the hall, being composed of an elaborate and most complete line of pipe coverings, cold storage insulating material, including Nonpareil Cork for every variety of service and a complete line of high-grade Magnesia Asbestos and Air Cell Covering; also Nonpareil Sheet Cork, and cork flooring. A handsome model showing the cork brine pipe covering applied, attracted much attention from refrigerating engineers. In fact, this exhibit was the best display of the kind that we have seen anywhere. It was looked after by our old college chum, Tom Brannen, who was one of the most popular men in attendance.

Jenkins Brothers occupied a double-sized space, handsomely decorated and furnished with easy chairs for the comfort of their friends. A few samples of the famous Jenkins valves and other specialties were shown, but, as usual, their attention was chiefly devoted to entertaining the visitors. Mr. Logan and Mr. McHugh, both old-time favorites, were in attendance.

O. F. Zurn Co., 25 South Fifth St., Phila., displayed a fine exhibit of the finest grades of lubricating oils, Peerless Boiler Fluids, for removal of incrustation, which prevents corrosion and preserves the boiler metal, and an exhibit of Oleaqua Hydraulic Compound for elevator systems, which seemed to interest the delegates greatly. It is said that this new compound will quickly improve the running of any hydraulic elevator system. This exhibit was in charge of Mr. C. J. Curran, Mr. J. D. Kelley, and Mr. John Zurn, all members of the Zurn Company and all the best of good fellows.

Watson & McDaniel, 147 No. Seventh St., Philadelphia, manufacturers of the famous McDaniel Improved Steam Trap, displayed a large assortment of traps of all sizes and also samples of their various other specialties, including the "W. & McD." Syphon Pump, Exhaust Heads, Relief Valve for water pipes, Reducing Valves for every variety of service, Separators, Blow-off Valves, and many other interesting specialties. Mr. Fred. Jahn was in attendance.

Vacuum Oil Co. had an elaborate exhibit of their well-known brands of lubricating oils and passed out neat little celluloid envelopes containing court plaster as souvenirs. The exhibit was ably looked after by Mr. D. C. Reynolds, Mr. J. L. Scott, and Mr. John C. Lee, all well-known representatives of the Company's Philadelphia office at 328 Chestnut St.

V. D. Anderson Co., Cleveland, Ohio, were represented by Mr. H. S. Meacham, their popular Philadelphia agent, who displayed a large number of Anderson Traps.

Harrison Safety Boiler Works occupied a corner space, which was admirably adapted for their exhibit, consisting chiefly of a handsome collection of framed pictures, showing the Cochrane Heaters and Separators in many positions and under all conditions. They also showed a small, neat model of each of their specialties and distributed a choice lot of descriptive literature.

Keystone Lubricating Co. distributed small sample cans of Keystone Grease, linen caps for engineers, and a large number of handsomely printed booklets, special circulars and other interesting literature describing the merits and various applications of Keystone Grease. These were all assembled in a large package and distributed with a lavish hand, being one of the most popular souvenirs of the occasion. The exhibit was in charge of Mr. Warren Buzby and Mr. C. A. Hopper.

Just Mfg. Co., 1215 Filbert St., Phila., pased out catalogues describing the Just Mechanical System for cleaning steam boilers, and also samples of Larkin's Metallic Packing, for which they are the local agents. Mr. T. D. Just did the honors.

C. J. Rainear & Co., 518 Arch St., Phila., were next in line with a handsome exhibit of White Star Valves, manufactured by the Wm. Powell Co., of Cincinnati. This booth was nicely decorated with flags and bunting, and in addition to the valves there was a complete line of Powell specialties, including sight-feed lubricators, grease and oil cups for every purpose, radiator valves, etc. Mr. Chas. E. McFarland was the popular representative in charge.

Mr. G. E. Tanberg with his natty Exhibit of Albany Grease

The attractive Exhibit of the Keystone Lubricating Co with Mr. Warren Buzby in attendance

"WE ARE HUNTING TROUBLE"
and We have the Remedies.
Compound for Elevators.
Boiler Compound for Boilers.
THE ZURN COMPANY. South 5th ST.

Popular Charlie Curran back of an elaborate display of Lubricating Oils and other Zurn products

Cancos Mfg. Co., 146 North Second St., Philadelphia, showed a very complete exhibit of their famous "Black Squadron" Packing, in which the visiting engineers showed deep interest. They also displayed large quantities of their other brands of packing, including "Globe," "Rising Sun," and "White Squadron," all of which are well known. As a souvenir they gave out copies of their interesting memorandum book entitled "The Engineer."

Manning, Maxwell and Moore's exhibit seemed to have a special attraction for the delegates. The new Improved Tabor Steam Engine Indicator with outside connected spring, and the new Hancock Valves were the features that interested them most. In addition to these, the firm exhibited a number of Metropolitan Injectors, "Pop" Safety Valves, Gauges, and other specialties. Mr. G. B. Gosman, of the firm's Philadelphia store, and Mr. Thos. G. Keogh, from the New York store, made excellent demonstrators.

The Mason Coal Co., of Fourth St. and Allegheny Ave., exhibited samples of "Star" coal for both steam and family use and gave out fire shovels, lifters and pokers, all of good quality and appropriate size for use in connection with a kitchen range.

Exhibit of Pipe Coverings and Insulating Materials by John R. Livezey with Col. Tom Brannon in charge

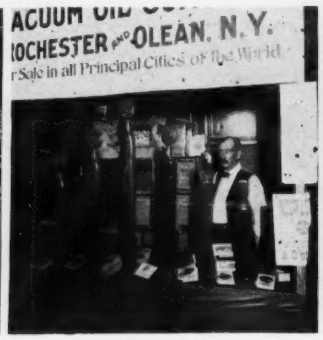
An Exhibit of McNelley's Boiler Compounds in charge of Mr. McNelley

Lunkenheimer's well arranged Exhibit of Engineering Specialties

The Liberty Mfg. Co., of Pittsburg, showed an interesting exhibit of their Liberty Boiler-Tube Cleaners, of which they had a large display, including all sizes and styles. The usefulness of the "Liberty" was ably demonstrated by Mr. W. A. Darrow, local agent, Girard Bldg., Phila.

J. C. McNelley, manufacturer of American Boiler Compound, displayed numerous interesting specimens of boiler scale and gave out a

Jenkins Bros. Exhibit
with Mr. A. P. McHugh in charge



Handsome "Dan" Reynolds
with his display of Vacuum Oils

The Garlock Packing Co.'s Exhibit
while Taylor and Morrison were not looking

most attractive and unique watch charm in the form of a complete little monkey wrench.

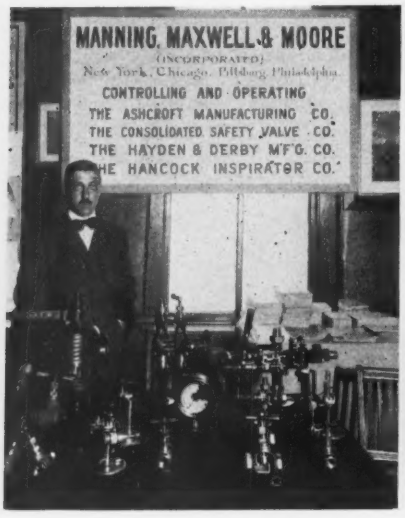
Adam Cook's Sons had an attractive exhibit in charge of their representative, Mr. G. E. Tanberg, who gave out handsome calendars and demonstrated the merits of Albany Grease.

E. F. Houghton & Co. exhibited a line of lubricating oils put up in handsome cases and attractively decorated. They also distributed booklets and other advertising literature describing the "Mark" steam trap, "Vici" hydraulic leather and many other specialties. Two colored musicians who were employed for the occasion entertained the crowd

ples of their well-known engineering specialties, including valves of every description, lubricators for every service, injectors, oil cups, grease cups, and other brass specialties in endless variety.

The Fairbanks Co., who act as local agents for many manufacturers, displayed an exceedingly interesting collection of steam appliances, chief among which were the well-known products of the Wright Mfg. Co., including steam traps, water columns, and gauges, and also Austin Separators, for which they are the Philadelphia agents.

The Geo. W. Lord Co., manufacturing chemists and makers of Lord's Boiler Compounds, occupied the second booth in the centre aisle, which


MANNING, MAXWELL & MOORE
(INCORPORATED)
New York, Chicago, Pittsburg, Philadelphia
CONTROLLING AND OPERATING
THE ASHCROFT MANUFACTURING CO.
THE CONSOLIDATED SAFETY VALVE CO.
THE HAYDEN & DERBY MF'G. CO.
THE HANCOCK INSPIRATOR CO.

Manning, Maxwell & Moore
with Mr. G. B. Gosman in attendance

Exhibit of H. B. Underwood & Co.
with Superintendent Rooksby to the right

C. J. Rainear's Handsome Exhibit
of White Star Valves and other Powell products

with songs and string music.

The Garlock Packing Co. showed samples of nearly a hundred styles of packing, including all of their well-known brands; also many specialties in mechanical rubber goods, including hose, pump valves and numerous articles of interest to engineers. One worthy of special mention is their new metallic packing, in which the engineers showed much interest. Mr. W. J. Taylor and Mr. E. H. Morrison were in charge and were kept busy passing out Garlock souvenir buttons.

The Dearborn Drug and Chemical Works occupied the centre space, which was handsomely decorated in yellow and black. Inside on a table in the centre of the booth were boxes of cigars, bottles of perfume to take home to the ladies, hundreds of lead pencils and many novelties, all free as the air. To be sure, some of the cigars were loaded but that

was handsomely decorated and furnished with an eye to the comfort of their visiting friends. Captain Doughty and Mr. Phillips were in attendance and both were kept busy. The Captain appeared to know every man at the Convention. He pinned roses on our coats, passed out net little pocket mirrors for souvenirs and otherwise exerted himself to add to the enjoyment of the visitors.

Other exhibitors were The Hyatt Roller Bearing Co., of Harrison, N. J., A. A. Griffin Iron Co., H. W. Johns-Manville Co., J. E. Rhodes Belting Co., and Mr. George H. Conner, the popular local manager for the Fitchburg Steam Engine Co., and who also fills the office of Eastern manager for Fulton Iron Works, of St. Louis. Mr. Connor is one of the best known as well as one of the most deservedly popular engine men in the country.